EnerNex

GRID MODERNIZATION STRATEGY AND IMPLEMENTATION

A White Paper

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Getting Business Stakeholders and Information Technologists to Talk the Same Language

Change

In today's world, change is the one certainty, and the rate of change is almost exponential. New Information and Communications Technologies (ICT) such as mobile devices are rapidly bringing new capabilities at lower costs to businesses, thereby allowing companies to improve efficiencies dramatically and develop new functionality. Generally, such changes also bring more companies into the market, and competing becomes more challenging. In today's marketplace, major changes are required to just stay even. It has become a matter of survival for most companies.

However, per Standish Group[11] only 29% of these capabilities are successfully deployed, and approximately 60% do not meet expectations. These failures can be attributed to a poor understanding of the corporate vision, gathering requirements, analysis, and management. As a result, a holistic methodology is used to understand the depth of change necessary to achieve the corporate demands and mitigate risk. The electric power system is the engineering marvel of the 20th Century; it is a complex System-of-Systems where any change may have wide impact. Over the last 11 years, several factors are accelerating the need to improve the power industry through an initiative known as Smart Grid. Grid Modernization (Smart Grid) drivers include the need for increased operational efficiency, utility mergers, new entrants to the industry (e.g.: information system technologists, service providers) and evolving green efforts by customers and society in general (e.g.: plug-in vehicles, home energy efficiencies, reduced reliance on fossil generation), and an increased desire to utilize renewable generation such as photo-voltaic (PV) arrays and wind turbines).

[1] Standish Group Chaos Report @ URL: http://blog.standishgroup.com/

North American power grid

While these drivers are evolving, business stakeholders, regulators and customer advocacy groups have complained about stranded assets from pilot programs, frequent budget overruns and schedule delays. These complaints are primarily due to a general misunderstanding of how Smart Grid capabilities transform business processes, organizational structures and supporting ICT. The fact that these costly undertakings fail to deliver the expected business objectives only serves to increase their frustration. Underlying causes include the complexities of the power industry, the intricacy and size of the applications, and limited communications between business executives, grid operators, power engineers, and ICT experts who all speak their own jargon. Meanwhile, the moving target of evolving business services, engineering practices and technologies exacerbates the situation.

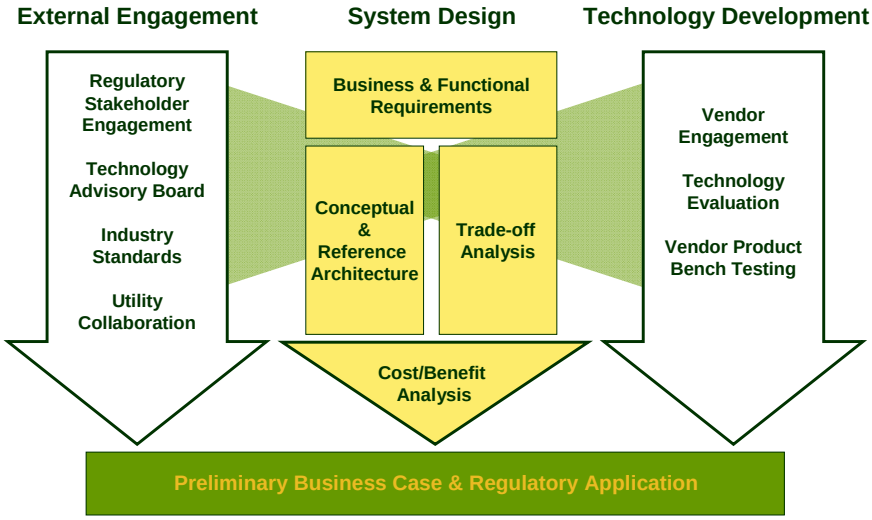
Safely evolving the power industry from its current operational state to one with Smart Grid capabilities requires organizations to maintain existing assets and processes while transforming its business techniques, organizational structure, operational processes and technologies. The size and scope of this change should not be ignored nor handled with inadequate preparation.

Actionable Approach

Many consultancies use proprietary approaches to these challenges by focusing on either strategic projects or siloed technical aspects of a client's needs. EnerNex solves these challenges by working with executives, managers and other stakeholders across the entire enterprise and individual operating-units to align the business strategy, mission and ongoing initiatives using an open, proven and actionable approach. EnerNex's approach is based upon client engagements, standards activities and industry best-practices. EnerNex's design blueprints follow and promote reference methodologies such as the EPRI IntelliGrid, The Open Group Architecture Framework and Service Oriented Architecture (SOA) Business Capability Management techniques.

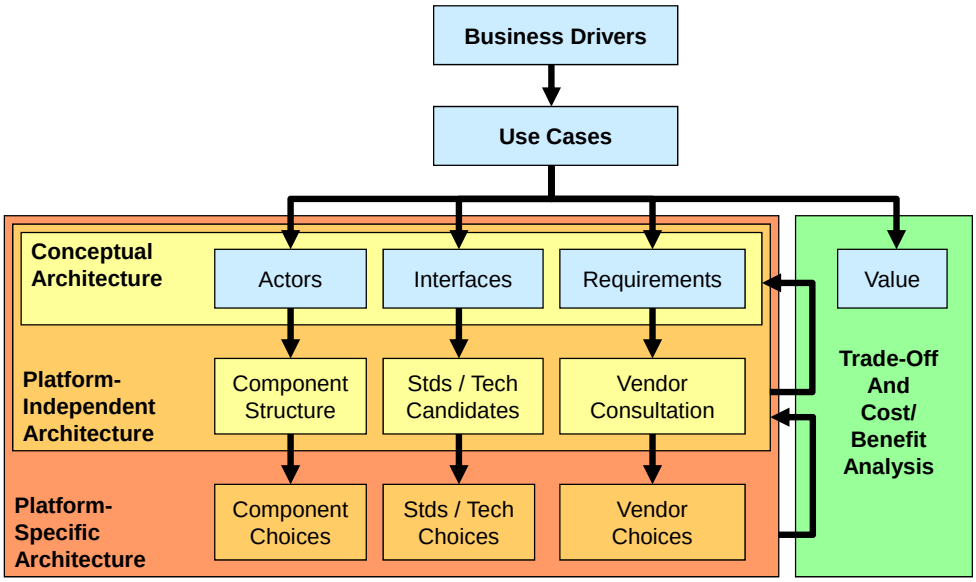
In the early 2000's EnerNex helped develop EPRI's IntelliGrid methodology[2] which minimizes risk and clarifies requirements. The focus of IntelliGrid is to have stakeholder perspectives (not just technologies) drive the process from the beginning. This integrated approach takes stakeholder requirements and balances them against technological capabilities to perform the desired functions. It leverages the widely-used software engineering "use case" approach, which is a top-down process to define requirements, system architectures, and select appropriate technologies.

2 IEC/PAS 62559 IntelliGrid Methodology for Developing Requirements for Energy Systems@http://webstore.iec.ch/preview/info_iecpas62559%7Bed1.0%7Den.pdf



An overview example of the ERPI IntelliGrid Process (for SCE)

A key linchpin in the EPRI IntelliGrid methodology is use cases which are developed from the stakeholder's drivers. Use cases identify conceptual participants, their interaction, the operational requirements and the derived value. These elements are used to define the generic component structure and standards, while seeking vendor consultations to ensure that the desired capabilities are commercially available and sufficiently mature to implement the use case scenario. The final step assesses vendor and customer applications that best meet the stakeholder's requirements.



EPRI IntelliGrid Methodology

The EPRI IntelliGrid methodology's focus across multiple business-units is a proven way to overcome siloed obstacles. This business driven approach encompasses the broad relationships between business strategies and processes, and the supporting information systems, data and ICT infrastructure.

Smart Grid roadmaps are an integral part of the EPRI IntelliGrid methodology, which assists business and ICT management in clarifying their long term desires. Smart Grid roadmaps are forward looking documents that weigh a utility's goals against its ability to execute, including the maturity of its ITC to deliver desired requirements.

While roadmaps establish the vision, the EPRI IntelliGrid methodology ensures a specific stakeholder's drivers are properly translated into an implementable ICT. They do not address several broader critical factors for an actionable plan, including:

- integrating specific drivers into an integrated, prioritized perspective;
- the impact use cases place upon the business units, including manual/outsourced procedures;
- developing a migration/implementation schedule;
- determining a governance plan to ensure changes and use are authorized by the correct responsible party;
- identifying a method to integrate future stakeholder or technological changes.

In partnership with several other utilities, EnerNex has been fundamentally responsible for developing, refining, documenting and disseminating information about this process, which has changed how the utility industry addresses Smart Grid challenges.

Architectural Methodology

Actionable blueprint

Like every building project, a plan should be put into place that details the project's objects; identifies capabilities, gaps, processes and the required services to achieve the goals; a detailed implementation plan; and ongoing maintenance requirements once the plan is put in place. Fortunately, several other industries have gone through a similar re-definition of their industry. To minimize risk, a disciplined methodology was developed to address an enterprise's entire mission and strategy. This approach looks at the entire enterprise to ensure actions that are taken consider the priorities and impact across the entire organization verses a more siloed initiative-by-initiative approach. By taking such an approach, an

organization may successfully understand and prioritize their needs before delving into the transformational activities that are necessary to implement them. EPRI's IntelliGrid methodology and roadmaps fold well into this enterprise-wide approach.

This enterprise-wide architectural approach is an enabling discipline that translates business vision, strategy and priorities into effective enterprise change. Enterprise architecture is organized into collections of elements including strategies, business roles, processes, information, and technology infrastructures. It defines the relationships between these elements and the principles that guide and govern how they are constructed and used to minimize risk and deliver business value.

To implement an enterprise-wide architecture five elements are used:

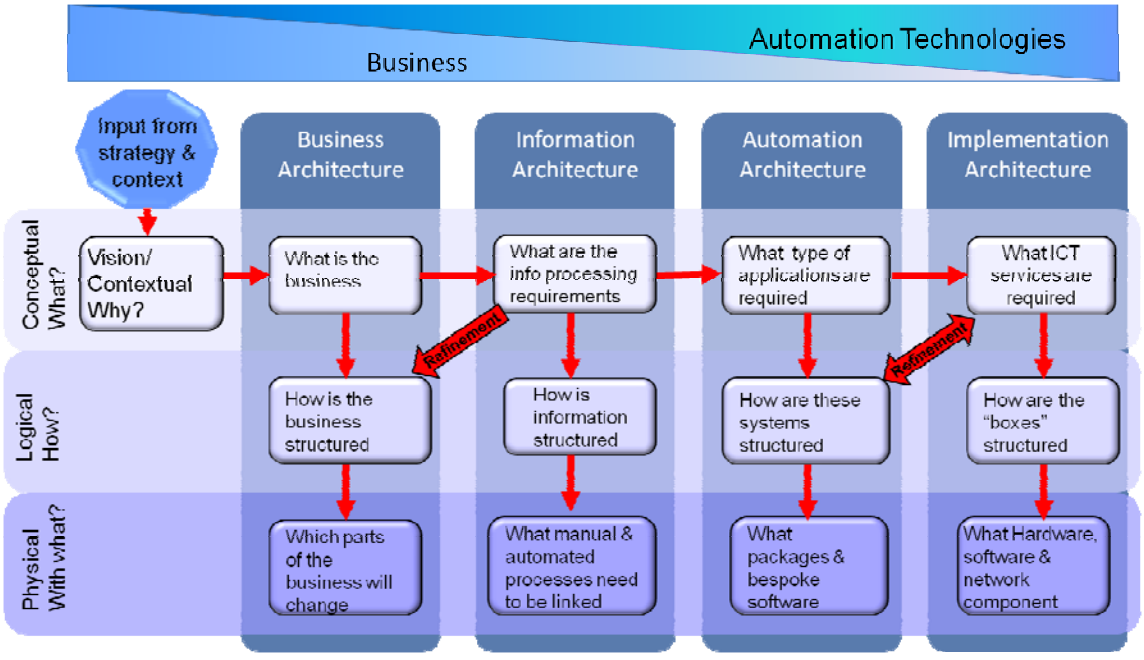
• Context/Strategy, which defines the current state of the company's enterprise in context of its goals, strategic vision, objectives and value propositions;

• Business architecture, which defines the business' organizational capabilities, business scenarios, services, roles, and terminology necessary to implement the strategy;

• Information architecture, which defines the personnel, processes and information needed to support the business unit's functions;

• Automation (information systems) architecture, which includes applications, services, components and other elements that support or implement informational requirements;

• Technology/Implementation, which defines the required hardware and software services to support the automation requirements.



This approach is successfully used by hundreds of companies across the world. It continues to evolve its business best practices, research and ITC offerings as they become available. Our own implementation of this approach merges EPRI's IntelliGrid, existing roadmap practices, our Smart Grid engineering and applications experience and The Open Group's Architecture Framework (TOGAF). TOGAF uses a phased approach to minimize risk while ensuring business vision and strategy are mapped to the organizational structure and required ITC.

Through workshops and one-on-one meetings, organizational and ITC changes are identified. This approach explores the implementation details of how the business will function in the new environment, and how each selected vendor or bespoke application/ITC infrastructure will support those business processes. A migration plan is also developed that will achieve the desired future state by studying the gaps between the current state and the targeted state.

Cross Silo Collaboration

Governance must be implemented based on existing and newly-identified policies and rules to ensure alignment between the business stakeholders, engineering and ITC. These are necessary to ensure that actions are performed by authorized individuals or ITC during a migration. Governance must also define the process that ensures future changes will be authorized by the appropriate entity.

Finally, all too often roadmaps and ITC plans become obsolete shortly after creation. TOGAF ensures changes in organizational strategy, structure or underlying ITC are mapped to the current environment while showing the extent of change necessary to help minimize effort and risk during implementation.

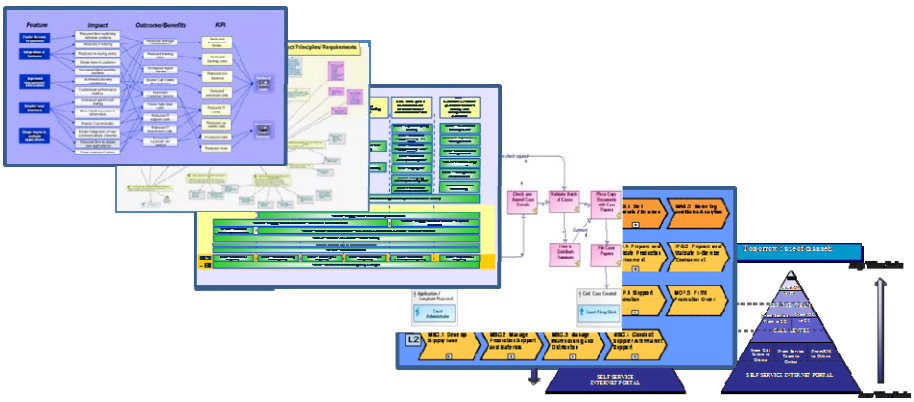
The diagram below summarizes these phases, as well as a repository that documents each phase's decisions and maps the relationship of those decisions to each other throughout the process.

TOGAF Architecture Design Methodology

Deliverables

This integrated architectural approach provides business agility, reduced operational cost, improved security and reduced risk. Enterprise architecture must be treated as a corporate asset. EnerNex has conducted several domain analyses, business strategy assessments, feasibility studies, ROI analyses, use-cases and requirements developments, risk analyses, and organizational change recommendations that resulted in enterprise system architectures.

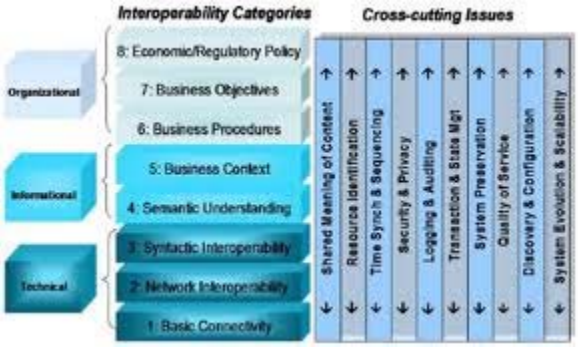
An engagement typically includes roadmaps, business flow diagrams, organizational charts, use cases, assessment charts, functional decomposition diagrams, business service diagrams, benefit diagrams, conceptual and reference diagrams, ICT infrastructure diagrams, matrices, gap analysis diagrams, migration plans, PERT-charts, life-cycle diagrams and executive-level presentations. While a vast array of deliverables is recommended, each engagement dictates the number, depth or applicability of a deliverable.



Sample Deliverables

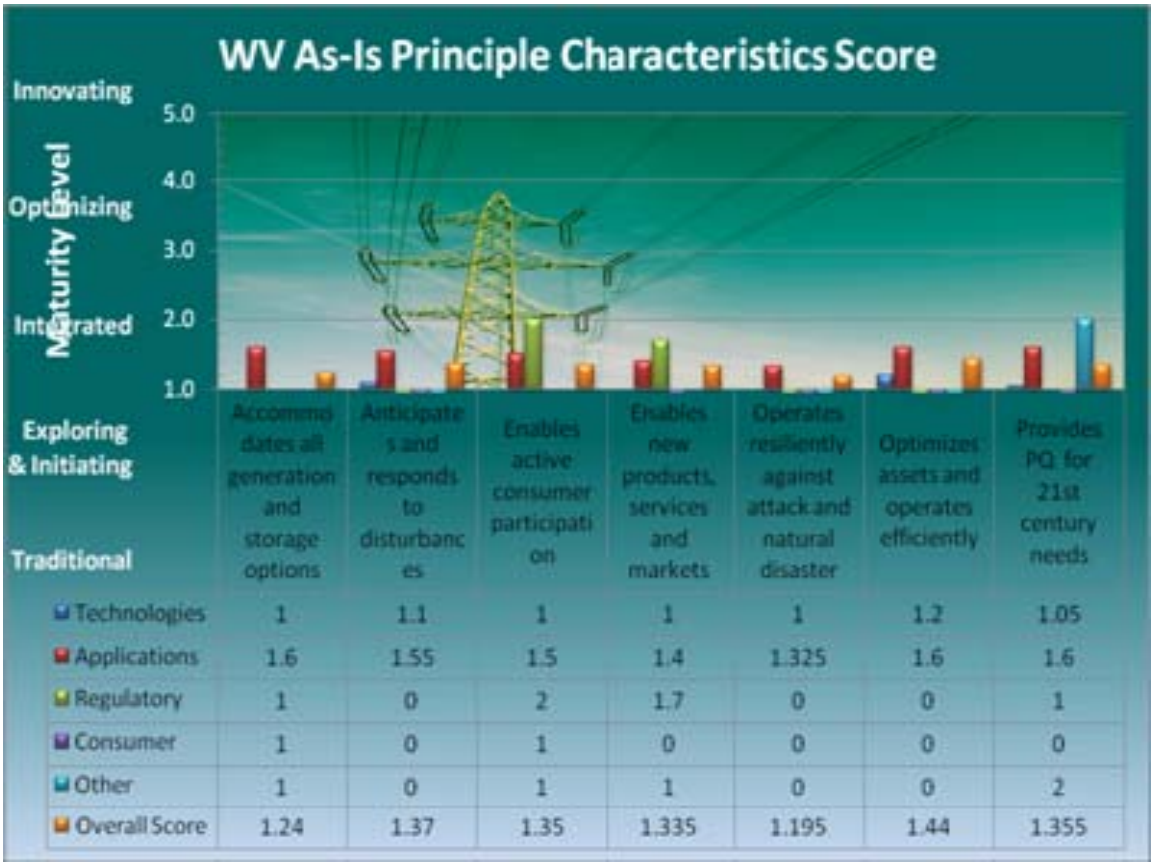
Design tools such as Sparx System Enterprise Architect should be used to capture the metrics and relationships between phases (e.g.: goals, requirements and services); UML diagrams for workflow; and leveraging web enabled services for interfaces (W3C's web semantic approach, which is a way to describe interfaces as semantic exchanges).

A capability/maturity evaluation is an important deliverable that is used to determine whether an approach is sound. These models assist with evaluating a client's maturity and capability to support and implement required functions, and the maturity and availability of these functions. Numerous maturity models exist or are under development for various Smart Grid aspects. EnerNex leverages, and in several cases, is participating in their development. An example includes EnerNex's membership in the group that is developing DOE's GWAC Interoperability Maturity Model efforts.



GWAC Stack

Additionally, EnerNex creates maturity models for its clients' unique requirements. A maturity model example developed for the State of West Virginia is shown below.



	Accommodates all generation and storage options	Anticipates and responds to disturbances	Enables active consumer participation	Enables new products, services and markets	Operates resiliently against attack and natural disaster	Optimizes assets and operates efficiently	Provides PQ for 21st century needs
Technologies	1	1.1	1	1	1	1.2	1.05
Applications	1.6	1.55	1.5	1.4	1.325	1.6	1.6
Regulatory	1	0	2	1.7	0	0	1
Consumer	1	0	1	0	0	0	0
Other	1	0	1	1	0	0	2
Overall Score	1.24	1.37	1.35	1.335	1.195	1.44	1.355

By developing a future-state vision, and the necessary supporting architecture and migration path enables businesses and engineering to fine-tune cost-saving efforts, mitigate effort and prioritize the projects. An entire future-state picture allows a business to realize crisp transformation and ongoing operations with minimal risk to the organization.

Summary

While various consultancies provide guidance for generic situations, EnerNex focuses only on the power industry. Many consultancies offer proprietary methods or solution-specific approaches while EnerNex provides a tailored approach that is based on Smart Grid and open cross-industry efforts.

EnerNex's offering is not restricted to the entire architecture spectrum; in fact many engagements may be limited to an expansion or distillation of results provided through other channels. EnerNex focuses on what makes sense for its clients while applying the appropriate level of granularity to its clients' requirements.

EnerNex's expertise includes:

- Unparalleled depth of Power System knowledge
  - Industry respected power engineering experts
  - Depth analyzing power grid delivery issues
- Leading Smart Grid expertise
  - Longest record supporting client Smart Grid efforts
  - Leading Smart Grid open standards efforts including NIST SGIP, GWAC IMM, DOE LIMNOS, OpenSG, OpenADR, IEC 61850 and DNP3
  - Leading Cyber security efforts
  - EPRI IntelliGrid and roadmap development
- Experienced enterprise architects
  - TOGAF certification
  - Extensive track record designing and implementing mission critical infrastructures