White Paper
THE DESTINY OF INTELLIGENT INFRASTRUCTURE

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Background

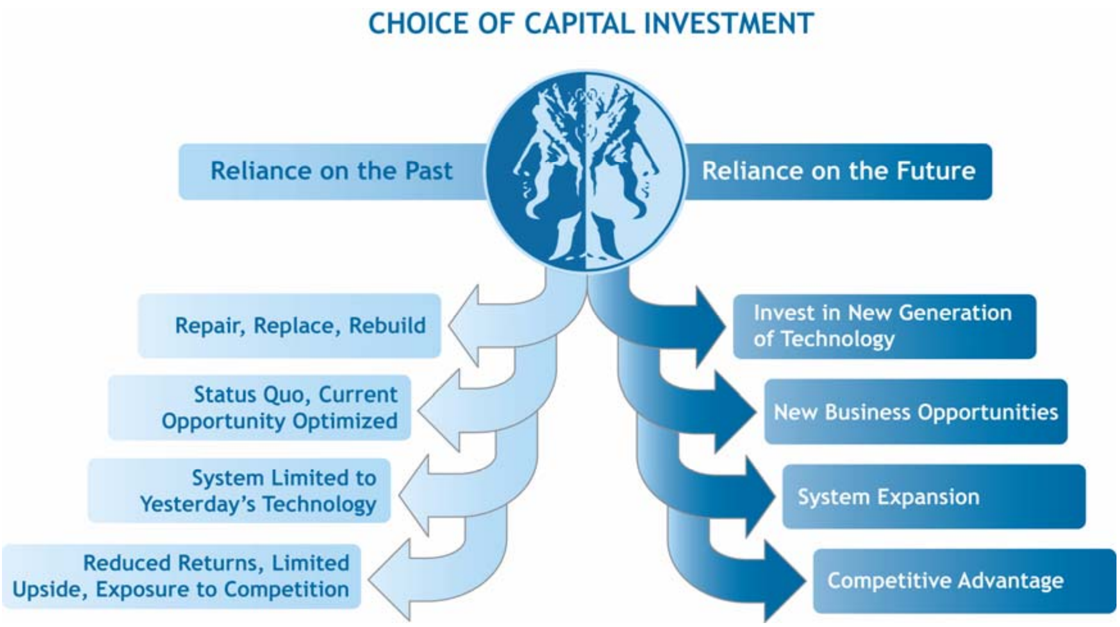
The implementation of distribution and substation automation, outage management, advanced metering infrastructure (AMI) and various other technologies are all leading to a digitally enabled, self-healing power network that provides equitably priced electricity to all classes of customers through ensuring the security, quality, reliability and availability of power. It will take time to evolve into a truly and fully integrated Intelligent Grid, yet it is happening now as a Megatrend of large potential impact – $28 billion will be spent in the next five years on transmission and distribution projects, much of it adding intelligence to existing systems.

Companies are challenged in their ability to adapt to and take full advantage of digitally intelligent system operations. These technologies require companies to think about management and operations in a new way. The constant flow of information coming from intelligent networks means a company can operate in real-time, using real data – enterprise wide – and this will require process reorientation. Companies need to understand their processes and be willing to reinvent their companies in order to gain the full impact of operational efficiency and the many benefits that are delivered by a fully integrated intelligent system. The sooner the better; those companies that can embrace these changes and adapt to the Destiny of Intelligent Infrastructure will be the companies that excel in the coming decades.

The development of a more sophisticated and reliable network is occurring across all energy markets enabled by communications, the microchip and advanced computational tools. From smart oil fields, which analyze flow rates, spots leaks and automatically balance CO2 injection, to the Intelligrid that automatically phase shifts, provides adaptive islanding capabilities and projects cable failures just prior to their occurrence, meshing intelligence with physical systems will put significant new demands on companies in exchange for powerful levels of control.

The reality is a more practical vision of an Intelligent Infrastructure – that of the emerging electronically-integrated energy provider that bridges information technology with system operations, power plant dispatch and trading all the way to the customer end of the business. For these systems to work, an extreme amount of native intelligence is needed in all devices, across all platforms and through each operating system.

The concept of the smart grid has suddenly gained mass media attention and is being spoken of as “fact” as if it can be purchased in a box and installed on energy systems as one would a transformer or circuit breaker. From Forbes to the Wall Street Journal, in nearly every utility in the country large and small, companies are declaring they are moving ahead with the smart grid. Perhaps no one is noticing the winces among those charged with making intelligent infrastructure happen after the CEO declares the company will be deploying a smart grid.



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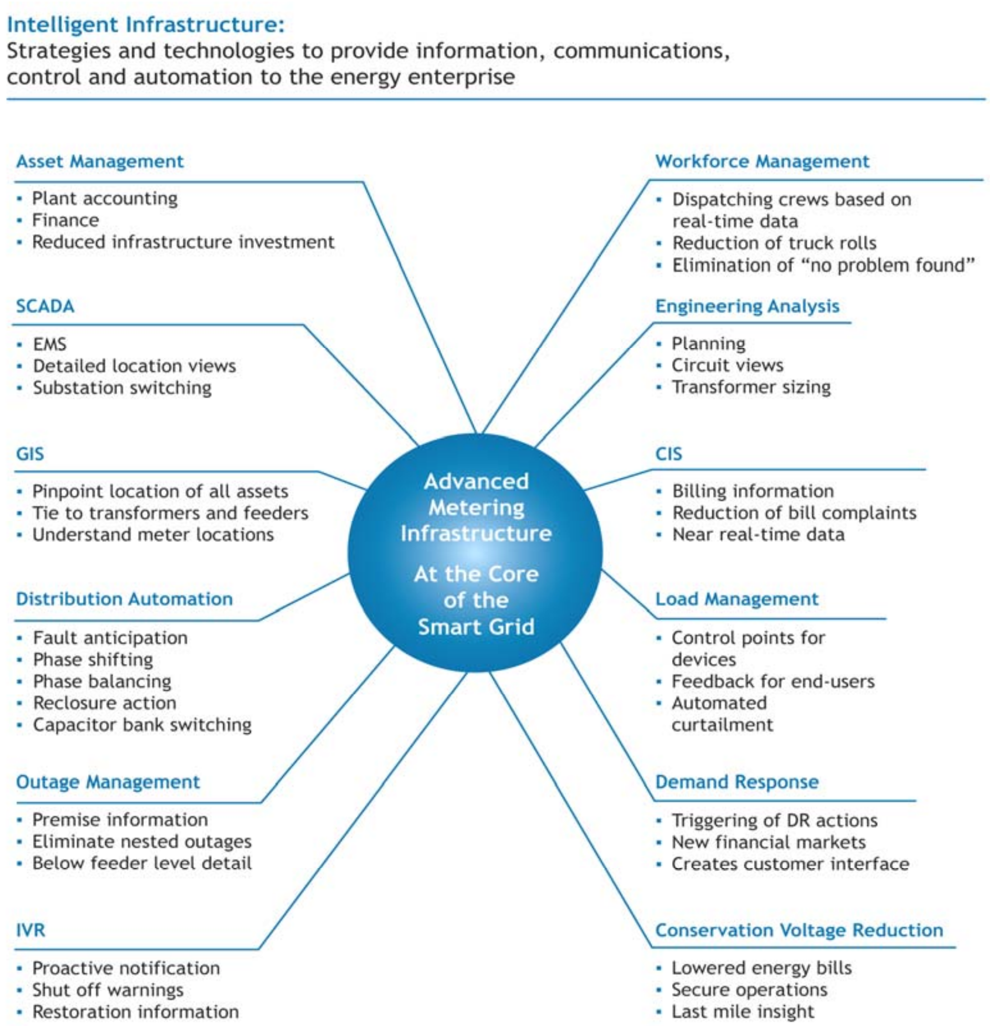
The good news is that, after 20 years of underinvestment in infrastructure, the industry is once again moving forward. The even better news is that after at least 10 years of discussion, the decisions being made are at least considering advanced technologies as the heart of the system. One of the major issues utilities face today is deciding whether to move ahead and invest in new technology that bears some risk, or to replace infrastructure with older, but more established equipment. This decision is even more difficult for investor-owned utilities that must face regulators not necessarily enamored with the increased costs of Intelligent Infrastructure—even though the long term benefit is great, Intelligent Infrastructure can meet the issues of carbon/capacity conflicts, align well with energy efficiency and fit the drive to customer engagement in energy markets.

Equally curious is the lack of an accepted definition of what a smart grid really entails. On different days a search on Google yielded 417,000 references to smart grid and, on another, 3,200,000. As amazing as that may seem, the concept of Intelligent Infrastructure is being co-opted by all sides of the energy stakeholder community. One reference touted the smart grid as "the answer to a post-fossil energy infrastructure" – whatever that means. Another spoke of "widespread wireless computing on every critical node." Still another described the smart grid as providing the capability for a distributed utility.

From a broader (and perhaps simpler) perspective, Intelligent Infrastructure can be described as strategies and technologies to provide information, communications, control and automation to the energy enterprise. It is important to note that this is not exclusive to electricity because gas is critical (so is water), and it is not exclusive to transmission and distribution systems because if it is to truly work, Intelligent Infrastructure will involve the entire value chain in energy from the home to the generator, dispatch systems to trading floors.

The Place for AMI/AMR

It can be argued that there is no smart grid without AMI/AMR at its core. Visibility to the substation is barely adequate; visibility to the pole top is useful; visibility to the end points is the key to a truly integrated system. We must also remember that there are currently more than 40,000 "dumb" substations, countless thousands of miles of distribution and transmission lines without SCADA, and many systems without basic operating controls. While AMI does not have all of the answers to system operations and control, the definition it provides makes it invaluable. This will require an expansion of current capabilities and a move to taking a leadership role in a market that is just now defining itself.



Changing Needs in a Changing Market

The days of a simple examination of the prudency of a drive-by AMR system have passed – except maybe in water only applications. The business issues and drivers for the systems will increase in complexity, and that creates additional opportunities in assisting clients. The pure view of cost reductions through the elimination of meter readers is giving way to a much broader need that looks at the carbon reductions achievable through an advanced metering system, understanding operational benefits over and above financial savings and figuring new ways for additional services to customers as well as improved asset management.

The impact of legislation such as EPACT, a strong push by the regulatory community and a desire by companies to be perceived as cutting edge is changing the nature of the work in very subtle ways. While many utilities still need a business case *analysis* to justify the deployment of an AMI system, more companies will need a business *plan* or a roadmap on how to get there since they have been given a mandate to "make it happen." In various utilities, the decision has been made to deploy AMI but the client still needs a business plan – they specifically do not want a business case. Relatedly, as Intelligent Infrastructure takes hold, utilities will need to develop capital budgeting plans that balance the needs of the system today with needs for tomorrow. This is evidenced in one utility where a multi-million AMI system was installed without recognition of the distribution group of its importance and impact. That group was in the process of buying a $1 million OMS, building two substations on speculation and reconductoring three, 400 KV lines – all without realizing the impact the AMI system will and could have on those projects.

It is possible the market will shift from a justification mode to a project management and control mode. This will not obviate the need to do business cases but may make the importance of the cost/benefit analysis less critical and the selection of the right technology, vendor and installer more so. Similarly, the regulatory community may look less at the cost and more at the functionality for the future – and proof that the savings anticipated and features added have been delivered.

All of these changes need to be coupled with process and change management since they strike fundamentally at the core of a utility's operations. Planning will be significantly impacted from a management as well as an operations perspective as the systems are deployed in new ways. Part of the justification for Intelligent Infrastructure is in the elimination of work and increased efficiency. Both of these require a major change in processes.

Current Unsupported Needs and Future Trends

Future trends are critical to the growth of the industry, some of which include:

- Intelligent Infrastructure
- The carbon capacity conflict
- A growing demand for customer engagement
- Tools to ameliorate the impacts of an aging workforce

Regardless of the trend, the success of business in the long term will require new talent, a revitalization of its skill sets and a willingness to invest in resources.

These future trends include areas such as system performance, the tracking of AMI and smart grid metrics for success, home area networks, water system enhancement, holistic system linkage, refresh and expansion of one-way systems, and prudency reviews. There may be a variety of new players who will try to use the systems for commercial needs – all with the permission of the utility – but who will need accurate accounting. Communications will undoubtedly expand and change to support multiple systems and we need to be ready to handle that challenge. As is the case in a number of communities, the political drivers have established a set of expectations that are fairly broad, and must be timed carefully to avoid setting unrealistic expectations.

TYPICAL AMI SYSTEM REQUIREMENTS AND TIMING

	Day One Requirements First Day of Operation	Day Two Requirements 6-12 Months from First Day	Day N Desired Requirements Future Needs
ELECTRIC	- Meter Reading - Billing - CIS Interface - Remote Disconnect - Read-In/Read-Out - Theft Detection - Tamper Notification - MDMS - Time Based Pricing - Thermostat Control	- Pre-paid Metering - OMS - IVR - Demand Response (Simple) - Web Interface - Automated Load Management - Customer Service Dashboard - SCADA/Switching - Load Planning/Forecasting - Power Quality Management/Reporting	- Advanced Demand Response - Fault Anticipation - Phase Balancing - Home Area Network Signaling
GAS	- Meter Reading - Billing - CIS Interface - Read-In/Read-Out - Leak Detection	- Tamper Notification - MDMS - Load Planning/Forecasting - Pre-paid Metering - IVR - Web Interface - Customer Service Dashboard	- Remote Disconnect
WATER	- Meter Reading - Billing - CIS Interface - Read-In/Read-Out	- Tamper Notification - Leak Detection - Theft Detection - Pre-paid Metering - IVR - Web Interface - Broken Pipe Detection - Customer Service Dashboard	- Remote Disconnect - Remote Rationing

As the issue of sustainability grows in importance, Intelligent Infrastructure will be a key for utilities and communities seeking to improve their profiles. This linkage will require a deep understanding of the issues of sustainability, how systems interact and the cost trade-offs.

Even concepts such as the PHEV (Plug-in electric hybrid vehicle), in which a vehicle has a small gas powered engine to charge batteries and can also be plugged in, require significant interaction with Intelligent Infrastructure. Touted by the electricity industry as well as some environmental groups, the level of sophistication necessary to deploy a PHEV model in which a consumer can plug in to an outlet in one place and have it charged to their home meter elsewhere requires huge levels of sophisticated communications, information, control and automation.

Investing in new infrastructure at a time of rising energy prices and rising demand remains the major challenge for utilities. Trying to balance the needs of a vastly improved and intelligent system with the cost requires a change in management philosophy, risk taking and regulatory mindsets. The fear of technology failure is not really at the core of this issue; it is rather the fear of making an investment with an uncertain time horizon and payback. Certainly there is some technology risk. However, adding sensors and control across a broad part of a system represents costs without significant risks. The challenge is that costs cannot easily be justified in a short period of time. Therefore, the need is to balance the risk with the reward system. It will require taking some chances in an industry that is not known for taking a gamble. However, the payoff and opportunities are great as the industry meets the challenge.