



WHITE PAPER

Ivara EXP supports a Smart Electrical Grid (SmartGrid)

The Power Generation, Transmission, and Distribution industry is undergoing a major transformation. Over 100 years ago the industry was designed based on a one way flow of energy from large fossil fuel generating stations to millions of consumers. The advent of advanced computer and communications technologies, combined with increased concerns about global warming, is leading to the development of a smarter electrical grid or SmartGrid. This design will support many more power generation sources based on low carbon and renewable resources. It will create a marketplace for electricity with dynamic pricing and a two way flow of information and power between consumers and producers. This white paper describes some of the key elements of this new SmartGrid, and outlines how Ivara EXP is one of the key tools in helping companies move toward a smarter electrical grid.



Figure 1: Future Network Vision from the European Commission SmartGrid Vision and Strategy Report

The Current Grid

If Alexander Graham Bell were brought back to life in 2010, he would be amazed at the advancements in communications technologies over the last century. Cell phones, digital switching, and the internet are all radical departures from his initial design ideas. If Thomas Edison were brought back to life in 2010, he would be impressed at the incremental improvements in power generation and distribution, but he would surely recognize the familiar model.

Large power generation stations primarily driven by fossil fuels feed high voltage transmission lines which transport power over large distances from remote generating stations to substations in major centers. The substations then push power in one direction through

the distribution system the end consumers in homes and businesses.

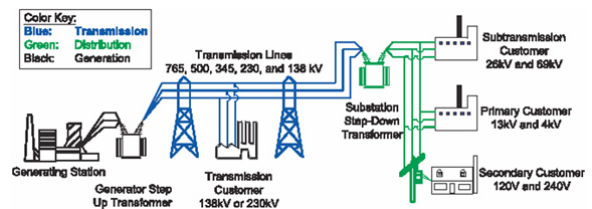


Figure 2: Electricity 101 from the U.S. Department of Energy



SmartGrid Definition

The European Commission defines SmartGrid as leveraging advanced computer communications and communications technologies to create a power distribution network that is

Flexible: fulfilling customers' needs whilst responding to the changes and challenges ahead;

Accessible: granting connection access to all network users, particularly for renewable power sources and high efficiency local generation with zero or low carbon emissions;

Reliable: assuring and improving security and quality of supply, consistent with the demands of the digital age with resilience to hazards and uncertainties;

Economic: providing best value through innovation, efficient energy management and 'level playing field' competition and regulation.

Similarly, the US Congressional Research Service states the goal of SmartGrid is to use advanced, information-based technologies to increase power grid efficiency, reliability, and flexibility, and reduce the rate at which additional electric utility infrastructure needs to be built.

The SmartGrid acts like a reliable marketplace with multiple producers, consumers, and arbitrageurs buying, selling, and temporarily storing power. Prices are dynamic and information flows freely in both directions to optimize the efficiency of the marketplace. Small producers of low carbon power get easy access to sell into the marketplace, and consumers have access to price signals that let them save money by shifting power consumption to off peak times.

For example, some consumers already let power utilities turn down their airconditioning slightly on high usage days or run their water heaters at night instead of during prime time. Future appliances will be smart enough to defer dish washing or clothes drying if electricity prices are above a certain threshold.

Smart Meters and Electric Cars

Two technologies that will hasten the migration to a smarter grid are the Advanced Metering Infrastructure (AMI) and Plug-in Hybrid Electric Vehicles (PHEV). Early smart meters sent electricity usage readings back to utilities, eliminating the need for someone to physically visit the house to read the meter. More advanced meters now have bidirectional communication, which would support the utility informing the home of dynamically changing prices.



A consumer with a plug in hybrid vehicle could charge their car when prices are low, and conceivably contribute electricity back to the grid at a profit if the price started to get really high. With these two technologies information and power are flowing in both directions and the line between producer and consumer starts to blur.

So what does all this have to do with Ivara and EXP?

Ivara's technology supports all of the SmartGrid goals.

1. Reliability
2. Efficiency & Flexibility
3. Reduced Capital Investment

Reliability

Power Generation, Transmission, and Distribution companies are using Ivara EXP today to increase the safety and reliability of their physical assets. This includes using Ivara's

- Asset Prioritization tool for identifying critical assets based on safety, environmental, and operational factors
- Reliability Centered Maintenance (RCM) techniques to identify technologically sound maintenance programs based on failure mode risk mitigation
- EXP mobile computing including handheld and tablet devices to capture manual inspection results in electronic form that drive complex health indicator calculations that can be used to trigger proactive work
- EXP interfaces to SCADA, data historians, and other online data sources to collect real time condition data
- EXP interfaces to SAP, Maximo, Passport, and other CMMS systems to automatically generate work orders to correct deteriorating conditions
- EXP interfaces to Graphical Information Systems (GIS) to leverage geospatial data for use in the



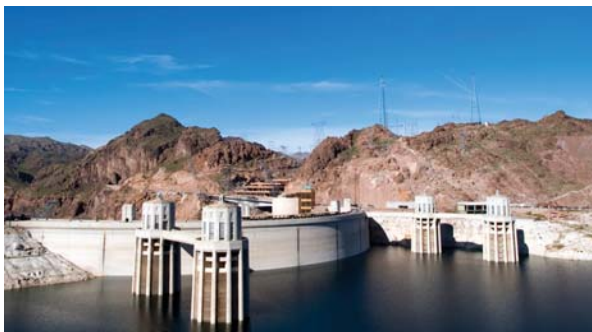
analysis of asset health and to display graphical alerts and work requirements in a real time environment

- EXP alarm panels, KPI Dashboards, and health Indices to monitor the overall health of the physical asset base

Ivara has demonstrated through numerous case studies its ability to increase asset reliability through the definition and implementation of proactive condition based maintenance programs.

Efficiency & Flexibility

Ivara is being used today to increase power company efficiency by reducing maintenance costs and reducing equipment outages through improved reliability. With SmartGrid there is an opportunity to further leverage Ivara technology. EXP's real time monitoring of asset health and forward knowledge of planned maintenance can be used not only to trigger maintenance work, but also to trigger changes in the price of power.



For the new SmartGrid electricity marketplace to be fully efficient, the price of power should reflect current demand and supply. The supply side depends not only on the availability and price of inputs such as the sun, wind, and fuel, but also on the availability of assets to

generate and transmit the power to the consumer. EXP has full visibility into asset availability and condition, and therefore can provide one of the key inputs into the dynamic pricing equation. In conjunction with other technologies that monitor raw material inputs and the demand side, EXP can be one of the key tools in generating a dynamic price that will lead to a flexible and efficient SmartGrid.

Reduced Capital Investment

One of the key decisions impacting performance and profitability in the power industry is the decision on whether to make a capital investment to upgrade your infrastructure, or continue to maintain your existing physical plant. The inputs to this decision are the current state of your assets and their expected deterioration, and the current state of customer demand and expected future demand.

Utilities are using EXP today to calculate health indices for critical assets based on historically reported problems, condition monitoring trends, and manufacturer and model specific characteristics. These health indices can be calculated automatically on a regular basis, driven by weights and factor tables that reflect the latest knowledge on how past performance can be used to predict future behavior. When combined with a criticality assessment of the impact of failure on projected future customer demand, a fact based model can be created to assess the costs and benefits of investing in new assets vs. maintaining the existing physical plant.

Conclusion

The power industry is undergoing a major transformation from a system that pushes power from large fossil fuel generators to a price driven marketplace that supports many smaller producers with a much lower carbon footprint. The SmartGrid leverages computer and communication technologies to increase the reliability of the generation, transmission, and distribution network, create an efficient and flexible electricity marketplace, and optimize capital investment decisions.

Ivara EXP is already being used by the power industry today to increase asset performance through improved reliability, and to improve capital planning decisions by leveraging intelligent asset health indices. Ivara EXP will continue to provide visibility into current asset condition, projected health, and expected planned maintenance. This will be one of the key inputs into a dynamic pricing model that will drive overall efficiency and flexibility in the maturing SmartGrid.



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