Guiding principle: Graceful degradation
A “well thought-out system …” something that can “build out and improve upon our existing system, but does not risk reliability for our most critical infrastructures and services ….”

In the IT sector, this concept is called “graceful degradation” – and in the context of upgrading our electrical grid, it can be viewed as an approach for prioritizing necessary upgrades, investing in new generation assets, and in emergency situations or events, allowing our electrical delivery grid to fail in predictable layers of demand.

This concept implies a concentric network of normal configurations that successively decrease into smaller areas of priority that, when faced with one or more failures – regardless of the cause of those failures – would ensure serving as many levels as possible until reaching the critical infrastructure that must operate at all times. This level would have the highest reliability requirements. One can visualize this as starting at the utility’s entire area of responsibility, then defining several concentric microgrid areas with critical buildings/campuses at the core.

This calls for a paradigm shift away from standard radial and lightly interconnected electrical network designs to delivery models that do not depend on a single source. Restorative automation is one aspect of this design, but it extends further to a grid design that has layered levels of supply capable of operating under emergency conditions.

Figure 1 Eco-district priority structure

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Siemens proposes to apply graceful degradation as a guiding principle for future infrastructure investments. This will provide an investment prioritization scheme for the utilities, the government, the city/municipality, businesses, and the individual.

Critical infrastructure: Self-sustaining electrical islands
The methods for maintaining supply at critical infrastructure (such as hospitals, water management, police and fire stations, military bases, etc.) should look to more than just back-up generation (diesel generation sets) for isolated buildings or systems, but toward self-sustaining power infrastructure including embedded microgrids. In a major storm or disaster, the availability of electric service should “degrade gracefully” into these self-sustained areas according to layered priorities assigned to different load areas.

Local generation and storage will allow sections of the electrical grid to operate independently in an intentional island during a major grid disturbance, such as widespread outages during the severe weather events. Locating generation close to the consumption will reduce the likelihood of downtime due to dependency on a long transmission and distribution network.

A microgrid will utilize distributed energy resources (power generation and storage) to provide energy when disconnected from the main grid. This typically includes a combination of fossil fuels and renewable generation and may include thermal (ex: chilled water) or electric storage. Importantly, a microgrid can be scaled for the different applications and end user requirements. A microgrid management system will aggregate and balance demand and supply in a defined area. These solutions should include important modern and “future proof” technologies including alternative generation sources, grid stabilization equipment, grid management software, energy storage, and a robust, secure communications network.

Summary
Microgrids are a fundamental component for developing grid resilience in areas of critical infrastructure. Multiple renewable and alternative-fuel generation sources (wind, solar, biogas) as well as fossil fuels will enable the microgrid to provide emergency backup as well as base load generation.

It will be the responsibility of a microgrid management system to balance the supply and demand, interface into the main grid and optimize the system for a chosen performance metric (cost, uptime, carbon footprint, etc.).

Key components: Microgrid
Any self-sustaining microgrid solution will consist of the following key components:

- Alternative sources of energy and storage
- Integration of traditional power distribution technology with information technology
- Open, standards-based information and communication systems.

These requirements will ensure real time control, interoperability and reliability in the event of an infrastructure failure.

Siemens solution: Microgrids
Siemens provides a complete microgrid solution along with the experienced personnel to design, execute, finance and support your long-term strategy. Regardless of potential microgrid location: hospital, military base, campus, or commercial center, Siemens is your one stop for a microgrid solution.