HITACHI ABB POWER GRIDS

Glendale Water & Power

Building a smart grid vision
for municipal power and water

Customer highlights

Challenges

- Developing a comprehensive smart grid program with limited resources
- Selecting a reliable cost-effective and secure field area network, scalable for future applications

Solution

- Wireless field area network with high reliability and performance, strong security, and ability to support multiple utility and municipal services
- Single vendor for backhaul of smart electric and water meter networks
- Leverages use of existing infrastructure: dark fiber; city light poles
- Scaleable as additional capacity and coverage is needed

Systems

- Hitachi ABB Power Grids Wireless
  - TropOS mesh routers
  - SuprOS network management
- Itron
  - OpenWay® power meters
  - Water SaveSource™ water meters
  - Itron Enterprise Edition™ (IEE) Meter Data Management System (MDMS)
  - Itron Enterprise Edition IEE Customer Care
  - MLOG water leak detection sensors
- Advanced Control Systems
  - PRISM OMS Outage Management and Distribution Management System
- Cooper Power Systems
  - Capacitor banks
- G&W Electric
  - Viper Reclosers
- Cisco
  - IE-3000 router
  - ASA 5520 firewall

Services

- KEMA
  - Project management, system integration
- City of Glendale Electric Services Department/ Utility Partners of America (UPA)
  - Installation of TropOS routers

Background

Formed more than a century ago, Glendale Power & Water (GWP) is a municipal utility located in Los Angeles County, California. It serves over 33,700 water and 85,300 electric customers and is owned by the City of Glendale. With a population of 194,478, Glendale is the third largest city in Los Angeles County and the seventeenth largest in the state of California. GWP has been recognized as a Reliable Public Power Provider (RP3). The RP3 designation is awarded to U.S. public power utilities that provide customers with the highest degree of reliable and safe electric service. GWP earned the RP3 designation from the American Public Power Association and is one of 176 public power utilities out of 2,000 nationwide, to earn this distinction.

GWP's aggressive smart grid implementation received the highest score of all smaller utilities and among the highest scores for all 93 utilities responding to a Smart Gird Maturity Model (SGMM) survey conducted by the California Energy Commission in 2011. GWP achieved the highest maturing level of all utilities surveyed in the areas of Strategy, Management and Regulatory as well as Organization and Structure. The resolves clearly demonstrate GWP's leadership and forward vision in developing a corporate level smart grid strategy.

Building Glendale Water & Power's smart grid vision

In October 2009, GWP was selected as one of just 33 public power utilities awarded a U.S. Department of Energy (DOE) Smart Grid Investment Grant (SGIG) to accelerate plans for modernizing its electric operations. The $20-million grant was towards a $51-million project, which included replacement of 84,000 electric and 30,000 water meters with smart meters. In March 2010, GWP became the first city in the nation to receive the SGIG funding to begin building their project. Under the terms of the grant award, the utility was required to complete the project by April 2013.

GWP's strategy was to implement their smart grid vision in three phases:

- Phase 1: An enterprise data center upgrade, MDMS, territory-wide AMI for power and water, a two-way communications infrastructure between the utility and each customer premise.
- Phase 2: Customer-facing demand response programs and solutions to provide visibility into utility usage, and to empower and encourage resource conservation.
- Phase 3: Advanced distribution automation applications across the utility's service territory.

Several items made GWP's situation unique. First, its smart grid plans were extensive, and it had limited resources to implement and support a smart grid program that was comprehensive and more ambitious than many of the programs proposed by larger utilities. Second, as a municipal utility, GWP also saw the opportunity to consider how its project could be leveraged by and benefit other city departments. Therefore, in addition to revitalizing its power infrastructure, GWP identified the opportunity to upgrade its water infrastructure, improving operational efficiencies and enabling faster leak detection.

As a result, GWP set out to identify:

- Requirements for the numerous applications and systems required for its smart grid.
- The most cost-effective and efficient approach and technologies to build its smart grid strategy.
- Industry-leading vendors that could extend the utility's resources and work collaboratively with it and other city departments.
- A wireless field area communications infrastructure that offered the capacity, security, manageability to support both the utility's requirements as well as other municipal applications.

Field area network challenges

"What we were facing in Glendale from a hardware, software, and backhaul perspective were the same fundamental issues as any utility transitioning to smart grid AMI," explained Terry McDonald, GWP's smart grid project manager and a consultant with KEMA, a global provider of energy consulting and other services to the energy and utility industry.

GWP's network communications imperatives were to identify a smart meter solution and a supporting field area communications infrastructure that could also be used for multiple utility applications including AMI, remote connect/disconnect, distribution automation, water leak detection, and many more. The plan was to utilize existing fiber at substations for backhaul to the utility's data center.

GWP determined that selecting a single vendor for both water and electric AMI would reduce its deployment risk as well as achieve important operational cost efficiencies. It chose to work with Itron, and selected its line of OpenWay® power meters and Water SaveSource™ meters and Itron Enterprise Edition™ (IEE) MDMS software to collect and manage the data from both the power and water meters. The utility also selected the IEE Customer Care – Mass Market tool allowing the utility and its customers to access current and historical water and electricity meter data online. GWP also chose to deploy Itron's MLOG leak sensors to enable faster detection of water leaks and therefore minimize water loss.

With its AMI solution identified, GWP developed criteria for its field area network. A key consideration was the desire to identify a solution that could be used for AMI backhaul in the near term yet provided the flexibility and scalability to meet communications requirements of future smart grid and municipal applications. The field area network criteria included the items shown in table 1.

Table 1: GWP Field Area Network Requirements

Reliability	Support mission-critical communications with minimum 99.999 percent network availability.
Resilience	Continues to perform in the event of a power outage, or severe weather, or disaster such as catastrophic seismic activity.
Cost	High performance private network that is cost effective to deploy and operate.
Capacity	Multi-megabit capacity to support multiple mission-critical applications and tens of thousands of network endpoints.
Coverage	Complete coverage of 100% of utility's 30-square-mile territory.
Latency	Achieve sub-20-millisecond latency to support distribution automation and other latency-sensitive applications.
Scalability	Ability to easily scale to support future applications, expand coverage area, increase bandwidth, and accommodate evolving industry standards.
Interoperability	IP standards-based; ability to easily connect and seamlessly communicate with network endpoints such as smart meters, mobile radios, and reclosers, as well as with the utility's fiber backhaul and mobile devices (laptops, phones, etc.).

Evaluating field area network technology alternatives

Glendale Power & Water weighed its field area communications infrastructure options against the criteria it had established and also considered approaches taken by other utilities.

Fiber

While fiber could provide a high performance solution for AMI backhaul, it was cost-prohibitive and inefficient to implement across the distribution area. However, GWP did identify that the City of Glendale had dark fiber at 13 of the utility's substations which it could light up as backhaul for smart grid applications.

GPRS

Commercial 2G/3G cellular networks were ruled out for several reasons. First, high availability. In a catastrophic event, commercial cellular network performance and availability would most likely degrade or be completely unavailable as people rushed to call emergency services and loved ones.

Second, commercial carriers did not have the coverage required to support GWP's AMI deployment. Additional cellular towers would be required and it was unclear carriers would perceive a positive business case in doing so. In addition, GWP anticipated public opposition to new cell tower sites which would impede the schedule or possibly derail the project.

Power line carrier

PLC was eliminated because its capacity was insufficient for multiple smart grid applications which require high performance and low latency.

Wireless broadband mesh

GWP contacted neighboring municipal utility, Burbank Water & Power (BWP), to find out about what they had selected for their field area network. BWP had deployed a TropOS wireless mesh for multiple smart grid applications including AMI, demand response programs, and a distribution automation system.

“In Burbank, we liked the fact that the installation had gone off without a hitch,” said McDonald. “And the reports showed that the network performance delivered there was commensurate with performance promised by Hitachi ABB Power Grids Wireless, which gave us confidence.”

When GWP evaluated the TropOS wireless mesh against the performance criteria as its distribution area network for AMI and distribution automation, it found that the solution measured up.

Capacity, cost & coverage

The TropOS wireless mesh solution had more than adequate capacity for GWP’s AMI backhaul needs and could scale to support distribution automation as well as other demanding applications in the future, while still being very cost-competitive compared with other solutions.

Latency

The TropOS wireless mesh can perform at sub 17 milliseconds latency. While low latency was not a requirement for AMI backhaul, it was a critical requirement for other smart grid applications such as distribution automation, which GWP had plans to support in the project’s third phase.

Reliability

Network availability was a high priority for GWP to assure support of its mission-critical utility operations. With 99.999% availability proven in live customer networks, TropOS met this requirement.

The unique TropOS technology was designed for creating highly reliable wireless communications. These features include dynamic configuring and optimization of mesh connections; seamless rerouting of traffic in the event of RF interference or disruptions; mobile client mobility and seamless handoffs between routers; and other advanced RF resource management techniques which increase reliability.

“The TropOS network appeared to be highly reliable,” said McDonald.

Scalability

“An advantage we saw in TropOS was that it was scalable,” said McDonald. By adding more gateways, nodes and possibly more fiber, the TropOS network was easily expanded and transitioned from simple AMI backhaul to support the most demanding smart grid and municipal applications. GWP also noted that adding more nodes and gateways made the network more robust and enhanced its self-healing capabilities.

“Every additional function that we add, if it requires more routers, actually gives everyone a more robust system,” explained McDonald.

Another benefit from a cost perspective: If other municipal users adopted the network for their communications, they would only face the incremental cost of expanding it to meet their needs making the investment extremely cost effective for the city as well as the utility.

Interoperability

The TropOS mesh architecture was IP-based and utilized open standards enabling TropOS routers to interface seamlessly with other applications and systems such as Itron’s smart power and water meters as well as GWP’s fiber network.

Security

The TropOS solution supported industry standard, multi-layered security plus was FIPS 140-2 certified. While GWP does not fall under NERC Critical Infrastructure Protection (CIP) requirements—standards intended to protect and secure bulk electric systems, the utility chose to strive to achieve NERC CIP compliance as a cyber security best practice. “We’re looking at our communication system the same way we would have for any critical infrastructure,” said McDonald.

Additionally, in evaluating the Hitachi ABB Power Grids Wireless reference site in Burbank, GWP noted that TropOS wireless mesh routers were performing in a system designed to meet the rigorous NERC CIP guidelines.

The rollout

GWP inked its DOE contract in April 2010. Before beginning the full rollout, an initial deployment of 1,000 electric meters, 500 water meters, 72 water leak sensors and 25 TropOS routers was carried out and successfully tested. The Hitachi ABB Power Grids Wireless team worked in close collaboration with the Utility, City of Glendale, Itron and GWP's installation vendor to ensure that even the smallest technical issues were identified and addressed immediately. Pleased with the pilot, GWP readied for the first phase of their smart grid rollout.

1. **Phase One: Full-Scale AMI Rollout**
   GWP started building its electric and water AMI systems from its data center out. That meant an initial overhaul of its data center with new equipment and software to support all aspects of AMI.

   Next, GWP lit up and incorporated dark fiber that was connected to 13 of its substations. Their plan was for this new fiber network to be used to connect the TropOS wireless mesh network back to the utility's data center. The utility's SCADA system would run in parallel on its preexisting fiber network.

   Before deploying the TropOS routers, each node was configured with up to seven VLANs for handling multiple applications securely. In addition, with TropOS, the utility can set priorities for applications, for example, more time-sensitive or mission-critical SCADA applications could be prioritized over AMI. GWP next connected the TropOS network to its fiber network and by October, was ready to rollout its smart meters.

   "The beauty of this approach is now that the network is ready, when you snap a meter in you can see it on the network and start using it right away," said McDonald.

   The full-scale meter rollout of 84,000 electric, 30,000 water meters and 250 TropOS mesh radios began in mid-October 2010 and was completed in June 2011.

   Utility Partners of America (UPA), working in collaboration with the City of Glendale's Electric Services Department, installed the TropOS routers. For the GWP smart grid deployment, they were attached to the city's light poles wherever possible. (TropOS routers are typically installed on utility poles, streetlights, and other such fixtures where power for the units is accessible.) The city's Electric Services team validated each location and, if power was needed, they wired it for a 120-volt AC connection. UPA rolled the trucks to install the radios. A handful of new poles were required to achieve the required coverage given the city's challenging terrain, but these represented only a tiny fraction.

> "The high throughput, extremely low latency, and network security features of the TropOS network enables it to provide secure communications for multiple Smart Grid applications. It will enable us to extend the system way beyond meter reading and help us build our vision of Glendale's Smart Grid—a power system that can automatically balance power supply and demand, conserve and optimize resources, reduce our carbon footprint, and reduce cost for our customers."
>
> Craig Kuennen
> Project Sponsor
> Glendale Water and Power

2. **Phase Two: Customer-Facing Program Rollout**
   With the AMI network in place, GWP began deployment of customer-facing programs. Opower's cloud-based Customer Engagement application is offered to GWP customers and enables them to view and analyze their own power usage. GWP is in the process of deploying web-based application(s) that offer customers the ability to access their power usage data on mobile devices; pay utility bills online through the SUS Mobile Pilot Program and view water usage via the web through WaterSmart solutions. In-home displays from CEIVA Energy through their Home View product connect to the utility via customers' digital meters and HAN.

   GWP offers an electric vehicle (EV) program wherein customers have the option to install an EV charging station (Level 2-240 V charger) in their home/business, which enables a faster charge rate, or use an existing 120 V socket. The utility does, however, require installation of a second electric meter at locations EV charging is to take place.

These customer-facing programs do not place any new demands on the TropOS network increase utilization of its two-way communication functionality between the utility and its customers. The network shares real-time usage information and enables remote connect/disconnect, theft protection and tampering prevention.

3. Phase Three: Distribution Automation Rollout of a distribution automation (DA) pilot began in early 2014 and includes four feeders. With DA, GWP expects to improve the reliability of electric service to customers further by reducing the number and duration outages. DA devices installed so far include Cooper Power Systems capacitor banks, G&W Electric reclosers, and capacitor bank controllers (GWP is currently evaluating products from four different manufactures at this time and at the end of the pilot, plans to select a single vendor). GWP has installed Advanced Control Systems' Outage Management and Distribution Management Systems (OMS/DMS) for real-time automation and analysis of the SCADA data, which is expected to help reduce downtime.

Initial results

With completion of Phase One of their smart grid rollout operational, GWP demonstrated that the TropOS wireless distribution area network met the needs of its smart grid vision in all key areas, as shown in table 2.

Future applications

- Mobile workforce management
- Connecting 168 Ice Energy systems
- Conservation voltage reduction (CVR)
- Extending reach of OMS/DMS

Table 2: GWP's TropOS Network Results

Reliability	- Self-healing mesh architecture provides built-in reliability. - Battery backup for routers assures network will stay up in the event of an outage.
Cost	- Proved to be as cost-effective as projected, helping the project proceed on budget. - Increased in cost-effectiveness with each new smart grid or municipal application.
Capacity	- Exceeded capacity needs for AMI backhaul (Phase 1). - Performed without propagation loss across challenging terrain. - Ready to support distribution automation capacity needs (Phase 3).
Coverage	- Provided the coverage required with very little mitigation and avoided stranded meters.
Scalability	- Easy to add capacity, expand coverage area, control getting coverage where and when needed.
Interoperability	- Integrated seamlessly with the Itron smart meter hardware and software as well as with the utility's fiber backhaul. - IP-based.
Security	- Protected sensitive data. - Controlled access to the utility's critical systems. - Separated utility applications from other city services.
Service & support	- Relatively simple and fast to install routers. - Supported by a company with a strong customer service ethic able to work productively in collaboration with the utility and its selected vendors.
Ease of deployment	- Installed conveniently on either streetlights or utility poles. - Was time-efficient to configure and install which helped the project deploy on schedule, an essential requirement to stay in compliance with the DOE's three-year timeline.

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