

## Glendale Water & Power

### Building a smart grid vision for municipal power and water



Formed a century ago, Glendale Power & Water (GWP) is a municipal utility located in Los Angeles County, California. It serves 33,400 water and 84,500 electric customers and is owned by the City of Glendale (pop. 195,505), the third largest city in the county.

In October 2009, GWP became one of just 33 public power utilities selected for a U.S. Department of Energy (DOE) Smart Grid Investment Grant to accelerate plans for modernizing its electric operations. The DOE awarded a \$20-million grant towards a \$71-million project, which included both electric and water AMI. Under the terms of the grant award, the utility must complete its project by April 2013.

#### Customer Highlights Challenges

- Developing a comprehensive smart grid program with limited resources
- Selecting reliable cost-effective distribution area network that could scale for future application

#### Solution

- Wireless distribution area network with high reliability, performance for multiple utility and municipal services
- Single vendor for smart electric and water meters
- Use of existing infrastructure: dark fiber; city light poles
- Phased smart grid roll out

#### Systems and Services

- Tropos GridCom™ architecture with Tropos wireless distribution area mesh network and Tropos Control wireless network management
- Itron OpenWay® power meters; Water SaveSource™ water meters; and Enterprise Edition™ (IEE) Meter Data Management Software (MDS)
- KEMA for project management, system integration

GWP's strategy was to implement its plan in three phases: 1) an enterprise data center upgrade, Meter Data Management (MDM) software solution and territory-wide AMI (power and water), and a two-way communications infrastructure between the utility and its customers; 2) customer-facing demand response programs and solutions to empower and provide incentive for customers to conserve; 3) advanced distribution automation applications across the utility's service territory.

#### Glendale Water & Power's Smart Grid Vision

Several additional factors made GWP's situation unique:

- 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.
- As a municipal utility, GWP also considered how its project could be leveraged by and benefit other city departments.
- In addition to revitalizing its power infrastructure, GWP recognized 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 distribution area communications infrastructure that could support both the utility's requirements, and support other municipal uses.



## Distribution 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 distribution area communications infrastructure that could also be used for additional utility applications such as distribution automation. The plan was to utilize existing fiber at substations for backhaul to the utility’s data center.

The utility determined that selecting a single vendor for both water and electric AMI would reduce its deployment risk as well as achieve important cost efficiencies. It chose to work with industry leader, Itron, and selected its line of OpenWay® power meters and Water SaveSource™ meters and Itron Enterprise Edition™ (IEE) MDM software to collect and manage the data from both the power and water meters. GWP 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 as well as Itron’s MLOG leak sensors to faster detect and therefore reduce water loss from leaks.

With its AMI solution identified, GWP developed criteria for its distribution area network that ensured it could be used for AMI backhaul in the near term and also meet communications requirements of future smart grid and municipal applications. The distribution area network criteria included are shown in the table below:

## Evaluating Distribution Area Network Technology Alternatives

Glendale Power & Water weighed its distribution 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 was 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 they would perceive a positive business case in doing so; and anticipated public opposition to new cell tower sites would impede the schedule or possibly derail the project.

### Power Line Carrier:

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

GWP Distribution Area Network Criteria	
<b>Reliability</b>	- Support mission-critical communications with minimum 99.999 percent network availability.
<b>Resilience</b>	- Continue to perform in the event of a power outage, severe weather event or disaster such as a catastrophic seismic event.
<b>Cost</b>	- High performance private network that was cost effective to deploy and operate.
<b>Capacity</b>	- Multi-megabit to support multiple mission-critical applications and tens of thousands of network endpoints simultaneously.
<b>Coverage</b>	- Cover 100% of the more than 30-square-mile utility service territory.
<b>Latency</b>	- Achieve sub-20 millisecond latency in order to support distribution automation and other latency sensitive applications.
<b>Scalability</b>	- Ability to easily scale for future applications, expand coverage, increase bandwidth, accommodate evolving industry standards.
<b>Interoperability</b>	- IP standards-based; ability to connect easily and communicate seamlessly with network endpoints such as smart meters, mobile radios, and reclosers, as well as with the utility’s fiber-backhaul.
<b>Security</b>	- Support for industry standards-based security at multiple levels to ensure system integrity and availability.

### Wireless Broadband Mesh:

GWP contacted neighboring municipal utility, Burbank Water & Power (BWP), to find out about what they had selected for their distribution area network, GWP reportedly had deployed the 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 Tropos, 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



### 2010 GridWeek Leadership Award for Smart Grid Deployment

Glenn Steiger, general manager of Glendale Water & Power, was recognized by GridWeek with the “Leadership in Smart Grid Deployment” award. The award is in recognition of his innovation and vision for the rollout of their smart grid program.

Steiger has established GWP’s smart grid initiative as a priority for all of the utility’s managers and employees. His unwavering support, extensive ongoing community outreach, presentations to foreign delegations and industry summits are the largest factors for success that distinguishes this project.

With a range of elevation changes across Glendale’s service territory, propagation issues were an initial concern for wireless technologies, but the utility’s propagation studies with the Tropos equipment showed that terrain issues could be overcome. Any cases where a Tropos router might be stranded were easily mitigated with some additional nodes to achieve 100 percent coverage.

“The apprehension about terrain issues proved to be unfounded,” said McDonald.

### Resilience

The self-healing nature of the Tropos mesh technology would provide for multiple paths in case of a node failure or in the event of a natural disaster which might potentially disrupt or disable other types of networks. Its integrated battery backup in each radio ensured each node’s continued operation in the event of a power failure, keeping the network up when it was needed most.

### 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. Tropos’ unique 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.

“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 which can automatically balance power supply and demand, conserve and optimize resources, reduce our carbon footprint, and reduce cost for our customers.”

Craig Kuennen  
GWP Project Sponsor

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

This feature had 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 GridCom architecture was IP-based and used on open standards enabling the 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 applications plus was FIP 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. In Burbank, GWP noted that the Tropos solution met the rigorous NERC-CIP requirements.

Additionally, in evaluating the Tropos 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 Roll Out

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 leak sensors and 25 Tropos routers was carried out and successfully tested. The Tropos Networks 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 the system's deployment.

### 1. Phase One: Full-Scale AMI Roll-Out

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. This new fiber network could 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, Tropos enables the utility to set priority 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 roll-out 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 roll-out of 84,000 electric, 30,000 water meters and 250 Tropos mesh radios began in mid-October 2010 and is scheduled to finish in June 2011.

The Tropos routers were installed by Utility Partners of America (UPA) working in collaboration with the City of Glendale's Electric Services Department. 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 were only a tiny fraction.

### 2. Phase Two: Customer-Facing Program Roll-Out

With the AMI network in place, GWP next plans to deploy its customer-facing programs including Home Area Network (HAN) solutions and creative ratemaking and incentives to promote conservation. An electric vehicle (EV) program is also anticipated given the expected influx of EVs in Glendale's garages

The customer-facing programs in phase two are not expected to put any new demands on the Tropos network but will make more active use of its two-way communication functionality between the utility and its customers. The network will be sharing real-time usage information and enabling remote connect and disconnect, theft protection and tampering prevention.

**Phase 3: Advanced Smart Grid Application Roll-Out** As with the AMI roll-out, distribution automation will start from the data center outward beginning with the installation of the required software tools. Field equipment deployment will follow including automatic cap bank switching, reclosers, a self-healing system and additional grid telemetry as needed. To support the business requirements for distribution automation, GWP anticipates expanding the Tropos network with additional gateways and nodes as needed to accommodate latency demands.





## Initial Results

With the initial roll-out of the system's first 1,000 electric and 500 water smart meters completed and operational, GWP demonstrated that the Tropos wireless distribution area network met the needs of its smart grid vision in all key areas:

<b>Reliability</b>	<ul style="list-style-type: none"> <li>• Self-healing mesh architecture provides built-in reliability.</li> <li>• Battery backup for routers assures network will stay up in the event of an outage.</li> </ul>
<b>Cost</b>	<ul style="list-style-type: none"> <li>• Proved to be as cost-effective as projected, helping the project proceed on budget.</li> <li>• Increased in cost-effectiveness with each new smart grid or municipal application.</li> </ul>
<b>Capacity</b>	<ul style="list-style-type: none"> <li>• Exceeded capacity needs for AMI backhaul (Phase 1).</li> <li>• Performed without propagation loss across challenging terrain.</li> <li>• Ready to support distribution automation capacity needs (Phase 3).</li> </ul>
<b>Coverage</b>	<ul style="list-style-type: none"> <li>• Provided the coverage required with very little mitigation and avoided stranded meters.</li> </ul>
<b>Scalability</b>	<ul style="list-style-type: none"> <li>• Easy to add capacity, expand coverage area, control getting coverage where and when needed.</li> </ul>
<b>Interoperability</b>	<ul style="list-style-type: none"> <li>• Integrated seamlessly with the Itron smart meter hardware and software as well as with the utility's fiber backhaul.</li> <li>• IP-based.</li> </ul>
<b>Security</b>	<ul style="list-style-type: none"> <li>• Protected sensitive data.</li> <li>• Controlled access to the utility's critical systems.</li> <li>• Separated utility applications from other city services.</li> </ul>
<b>Service &amp; Support</b>	<ul style="list-style-type: none"> <li>• Relatively simple and fast to install routers.</li> <li>• Supported by a company with a strong customer service ethic able to work productively in collaboration with the utility and its selected vendors.</li> </ul>
<b>Ease of Deployment</b>	<ul style="list-style-type: none"> <li>• Installed conveniently on either streetlights or utility poles.</li> <li>• 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.</li> </ul>

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