



Advanced Meter Infrastructure Smart Metering Plan Business Case



City of Glendale Water & Power

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1. Introduction

In April 2008, the City of Glendale Water & Power (GWP) engaged KEMA, Inc. to evaluate the economic effectiveness of developing and deploying a Smart Metering Plan for its electric and water customers using an Advanced Metering Infrastructure (AMI) system.

This report presents the business case for AMI and the processes used and information considered in building the case.

1.1 Scope of the Study

The assessment includes:

- Development of high-level requirements for AMI.
- Development of alternatives to meet the AMI requirements.
- Estimation of the costs and benefits for each alternative.
- Recommendations for the future of AMI at GWP.

The study has been divided into two phases:

- Phase One: Development of a Technology Plan for AMI.
- Phase Two: Preparation of the Business Case.

1.2 GWP Vision Statement

The Advanced Metering Infrastructure (AMI) will align with the City of Glendale Water and Power (GWP) corporate vision. AMI will provide better system visibility to support a Smart Grid (Grid of the Future), increase Customer Satisfaction, and promote Environmental Stewardship. AMI will empower customers to make intelligent choices to reduce cost and maximize energy efficiency and water conservation.

1.3 Guiding Principles

Recommendations made for the AMI must respect the following principles, commensurate with best practice in the electric power industry:

- Align with GWP vision and strategy.

- Prepare for new initiatives required by the California Energy Commission (CEC) and other agencies.
- Purchase off-the-shelf components, including software, where practical.
- Avoid commitments to limited lifetime and proprietary technology.
- Implement a system that can readily incorporate new requirements and that can readily exchange data with other systems.
- Minimize disruption to operations when implementing AMI.
- Follow electric power and water industry standards wherever possible.

1.4 Deliverables and the Contents of this Report

The work plan for this assignment promises the following deliverables. The form of the deliverable and its location, within this document or elsewhere, are described.

- Phase One: Development of a Technology Plan for AMI

Mobilize Project Resources

- Team contact list – The contact details for GWP and KEMA staff participating in this assignment are contained in the Project Procedures Manual uploaded to the GWP project Microsoft Office SharePoint site (the GWP SharePoint site) maintained by KEMA. This site is available to selected GWP team members.
- Management work plan, including activities, timing, responsibility, resources, critical path, and interdependencies – The work plan is included with the GWP contract and revised, as needed, in the consulting status report issued monthly and uploaded to the GWP SharePoint site.
- Project kick-off presentation – The kick-off meeting was held at GWP offices on April 16, 2008 and presentation materials are uploaded to the GWP SharePoint site.
- Initial issues identification and logging, including description of issues and resolution status – The action item list is maintained on the GWP SharePoint site.

Assess Current State Situation

- Interview summaries, as necessary – interview results were collected and are summarized in this report.
- Written summary describing the GWP business context for AMR/AMI, including both business and technology environments – This is presented as Section 2 of this report.

Develop Future State Vision

- Coordination and facilitation of a strategy alignment workshop, workshop presentation materials, and document outlining a summary of workshop sessions and key conclusions – Workshops were conducted with GWP executive and management staff and the GWP Steering Committee on May 20, 2008 to review the preliminary strategic alignment matrix. Results of the GWP Strategic Goals and Objectives and alignment workshop are uploaded to the GWP SharePoint site. The summary of workshop(s) sessions and key conclusions are presented in Section 3 of this report.
- Defined vision statement document with accompanying matrix specifying alignment of the vision to department goals and metrics – the vision statement is contained in Section 1.2 above and the AMI Alignment with GWP Goals is contained in Exhibit 3-2 of this report.

Develop Technology Plan

- Coordination and facilitation of a technology workshop and workshop presentation materials – Workshops were conducted with GWP technical staff and the GWP Steering Committee on May 20, 2008 to identify current technology infrastructure. The technology workshop presentation is uploaded to the GWP SharePoint site. A summary of available AMI technology is included in Section 4 of this report
- Phase Two: Preparation of Business Case

Specify Key AMI Requirements

- Document specifying GWP’s functional and non-functional AMI requirements – Included in this report in Section 4.

Impact Assessment of AMI on Electric Utility Operations and Technologies

- Prepare and deliver a set of benefit and cost slides that describe the benefit, assumptions, and calculation basis. The benefit and cost slides are in separate files: GWP Executive Presentation and GWP Financial Workshop.

Develop Financial Model and Assess Strategic Options

- AMR/AMI financial model in Microsoft Excel –This business case and KEMA’s analysis using the financial model are in Sections 5 and 6. The financial model in Microsoft Excel is in a separate file: GWP AMI Financial Model. This analysis and summary covers the following deliverables:
 - ◆ Economic comparison across technology and deployment options.
 - ◆ Strategic options financial summary.
 - ◆ AMI business case, providing costs, benefits, and return on investment (ROI) calculations.

1.5 Report Contents

This report is divided into the following sections:

Section 1, Introduction – This introductory section.

Section 2, Current Business and Technology Context – Outlines the infrastructure and processes employed to collect electric power and water consumption data from meters and to process the information into customer invoices.

Section 3, Strategic Alignment – Examines the capabilities of advanced metering and determines how those capabilities align with GWP’s corporate strategic plan.

Section 4, Future State – Develops the functional and non-functional requirements of the new metering infrastructure. Specific technologies and architectures are examined and those that will not meet GWP’s needs are identified and removed from further consideration.

Section 5, Business Case and Financial Model – Develops a business case for the viable alternatives. Costs and benefits, both tangible and non-tangible, are developed and analyzed. Many of the details of the analysis are included as separate attachments to this report.

Section 6, Key Findings – Highlights the key findings of the analysis.

Section 7, Recommendations – Provides specific recommendations that GWP should consider in the near and mid-term.

2. Current Business and Technology Context

The meter reading and processing functions at GWP are divided among several internal organizations:

- 1) Meter reading responsibility is shared between the Meter Readers and Field Services under Customer Services, Electrical Meters and Test Shop Section of Electrical Services, and Water Meters and Test Shop of Water Services.
 - a) Meter Readers read most of the residential and commercial / industrial electric and water meters using handheld devices or using walk-by AMR technology for hard to read meters.
 - b) Meter Shop personnel read some of the large totalizer installations.
- 2) Customer Services transfers the readings into metering systems and then into the Customer Information System (CIS).
- 3) Information Services supports the CIS.
- 4) Customer Services is responsible for the meter data and billing.

About 70 GWP staff performs meter reading, shop repair, billing, and collections tasks as their primary responsibility. The division of responsibilities and the general form and processes performed by GWP are typical of many similar utilities. A diagram of GWP's current state is shown in:

Exhibit 2-4, GWP Current State Meter Reading and Processing.

2.1 Meter Count

The meter count is shown in Exhibit 2-1, GWP Customer and Meter Count by Category.

- **Electric accounts:** Commercial & Industrial (C&I) electric meters consist of categories – A, C, SB, I, CM and CA. Total count for commercial electric meters is 11,779. All other meters are residential (KWH only) and total count for residential electric meters is 72,802. 70% of the C&I customers have dual meters (120/ 240V single phase and 240 V three phase delta) if the service provided is single phase and three phase. 1 to 2 % of the meters are old enough to have questionable accuracy and should be replaced. If some meters are hard to read due to accessibility issues, they are replaced with AMR meters (drive by or walk by reading from meters which can transmit RF signal) and in general 90% of any other replacements are also being changed out with

the new AMR type meters. All commercial & industrial meters are tested before installation while only 10% of the residential meters are tested for single phase applications.

- **Water accounts:** Commercial water meters consist of the same categories as Electric except category A. Total count for commercial water meters is 4,076. All other meters are residential and total count is 30,204. Most of the meters are 23 to 25 years old.

Exhibit 2-1: GWP Customer and Meter Count by Category

ELECTRIC and Water TOTALS BY CATEGORY FOR FY 2007-2008

Category Code	Category Description	Electric Customer Count	Electric Meter Count	Water Customer Count	Water Meter Count
A	COMMON USE AREAS FOR APARTMENT OR CONDOS	3,203	3,372	2,873	3,043
C	COMMERCIAL BUSINESS	1,675	2,274	1,856	2,139
CA	COMMON USE ELECTRIC/WATER FOR BUSINESSES	29	28	10	12
CD	CONDOMINIUM UNITS	7,795	7,093	367	401
CM	COMMERCIAL W/MASTER-METERED WATER (BUSINESS)	31	36	26	27
F	ELECTRIC/WATER SERVICES - NO FACILITY	576	643	10	11
G	CITY OF GLENDALE	350	389	238	277
I	INDUSTRIAL - LARGE BUSINESS	253	294	132	190
IR	IRRIGATION METERS	17	19	214	227
M	MULTI-FAMILY RESIDENTIAL	45,609	39,960	2,752	2,838
MM	MASTER-METERED RESIDENTIAL	225	235	139	149
MW	MULTI-FAMILY W/MASTER-METERED WATER	290	306	511	536
PA	PUBLIC AUTHORITY	12	12	1	1
S	SINGLE FAMILY RESIDENTIAL	25,136	24,145	22,318	23,226
SB	SMALL BUSINESS	4,877	5,775	1,133	1,203
Total =		90,078	84,581	32,580	34,280

2.2 Meter Installation, Maintenance, and Reading

Meter Services has 6 people in the electric meter shop and 5 people in the water meter shop. These people provide installation and maintenance services. Meter Services is largely a weekday operation.

The meter reading cycle for residential accounts is every other month while C&I accounts with only demand type meters are read every month. Residential customers are only billed on KWH. C&I customers are billed based on demand in addition to the KWH reading. As C&I customer are billed based on demand and are on a monthly cycle for meter reading, all meters at the premise are read even if they have meters without any demand element.

Meters for small accounts, most residential and small commercial accounts, are read by the meter reading group within the Customer Services department. GWP currently has 8 meter readers, 1 Senior Meter Reader, and 1 vacant position. There are total of 6 field techs and one senior field tech providing most of the single phase field modifications, turn off, turn on and special read services. The Electric meter shop working under Electrical Services provides all the totalizer metering readings. The read cycle is 21 (business) days. The route for each reader is downloaded from an Itron (multi-vendor meter reading system) MVRS to a handheld device at least two days in advance of the read day (this allows for an outage of the CIS).

At the end of a read day, the handheld is returned to a cradle for charging and for upload of the meter data from completed routes to MVRS. Partial routes are not uploaded till they are completed. The MVRS performs an initial validation of the read data (such as checks against high and low limits) and transfers the validated data and tags (indicating missed reads, meter tamper indications set by the reader, and other anomalies) to the CIS using ftp (file transfer protocol). Off cycle reads, such as move-out, move in, disconnects and reconnects are handled outside the normal billing cycle reads.

Approximately 6000 electric meters were changed to an RF based communication system and are read by a walk-by radio based system (AMR). Meter exchanges to AMR are decided based upon safety issues such as dog on premise, hard to read due to access or difficult location such as a long driveway on a mountain top. These meters are read in the same cycle as manual reading and uploaded to MVRS. These hand held devices containing information for the hard to read and all other manual read meters are uploaded every evening to the MVRS.

Residents moving in and out of the premise will require special reading of the meters. "Soft On" and "Soft off" is only used for multi family apartment customers. Special reads are performed when billing determines that there was a mistake in recording a reading or reading is kicked out on "HI – LO" test or the customer complained about a Hi bill and billing wants the meter to be read again.

At one time, a few dozen interval meters were installed as an experiment for large customers but, due to communication issues, this experiment was dropped.

The meter readers are also the first line of defense against tampering and theft. The meter readers' physical inspection of the meters is the initiator of most tampering and theft investigations.

2.3 Account Disconnection and Reconnection

Accounts are disconnected and reconnected by staff within the Customer Services department. A staff of 6 techs, 1 field tech, and 1 senior tech perform the disconnect/reconnect services.

GWP disconnects approximately 300 accounts per month (3,663 from July 1, 2007 to June 17, 2008 – high 400 and low 120 during December 2007). Most of the accounts disconnected in a typical day are reconnected that same day, but there is very little overtime offered for turn on. Disconnect fee is \$25 and reconnect fee is \$25. For same day turn on customer needs to pay \$50 but there is no promise that it will be accomplished same day. If the temperature is 100 degrees for 3 days, disconnects due to non pay are postponed.

2.4 Information Services

Information services (IS) supports the Customer Information System (CIS) from Harris provided by Northstar in Canada. The CIS system is owned by GWP and is located in-house. The system's live date was May 10, 1999. GWP does not plan to replace the CIS during the next 5 years.

2.5 Billing

The Billing department has the responsibility to review the bills, generate estimated reads, and manage meter change out requests. Approximately 2700 to 3,000 bills are estimated each year. The billing system has redundancy built in by having a duplicate system located in the meter shop. There are a total of 7 customer service representatives, 1 senior customer service representative, and 1 supervisor in the billing department. An average of 2.75 people work on billing exceptions and 1 person working on billing adjustments. Many of the adjustments are about move in and move out dates. Other issues may be pertaining to "hi – bill" and "who bill" (For some reason customer calls GWP complaining that bill does not belong to them. Billing has to spend a substantial time investigating who the legal owner is for the bill and initiates phone calls to determine the legal owner of the bill.

2.6 Turn Offs for Non Pay

Non paying customers need to be notified three times before their premise is disconnected. The first notice is sent 23 days after the utility bill is issued. The second and final notice is sent 38 days after the

bill issue date and a call is made to the premise. The premise is eligible to be turned off 45 days after the bill issue date and a notice is left on the front door. Master metered premises require posting of physical notice at the premise. Depending upon the workload, it may take many days to turn off a customer after the final notice.

Special reads, “turn off” and “turn on”, “Move On” and “Move Off” services are performed by 6 field techs and 1 senior field tech.

2.7 Outage Management and Power Quality

Outages are managed by collecting information through various sources: Customer calls, SCADA, and Field Personnel. As this stage there is no information available for an outage at the customer’s premise unless the customer calls Customer Services. After the circuits are restored, some customers may still call in an outage. Electric Operations does not know if the problem is on utility side of the meter or on the customer side of the meter. A trouble person has to be dispatched to evaluate the situation and, many times, the issue is on the customer side of the circuit. Availability of real time data, specifically regarding the premise outage will increase better operational efficiency, reduce the outage time and lead to better customer satisfaction.

The meter shop has one person performing Power Quality investigations, mostly for commercial and industrial customers.

2.8 Planning and Engineering

The Electrical Services department converts meter usage data for their analysis of transformer and feeder branch loading. Availability of real time data is perceived to enhance planning capability and may, in the long term, improve asset utilization.

2.9 Systems and Communications

The computer systems used in meter reading and processing are described in the above sections. In general, the systems perform well and GWP has no immediate plans to upgrade or replace the systems.

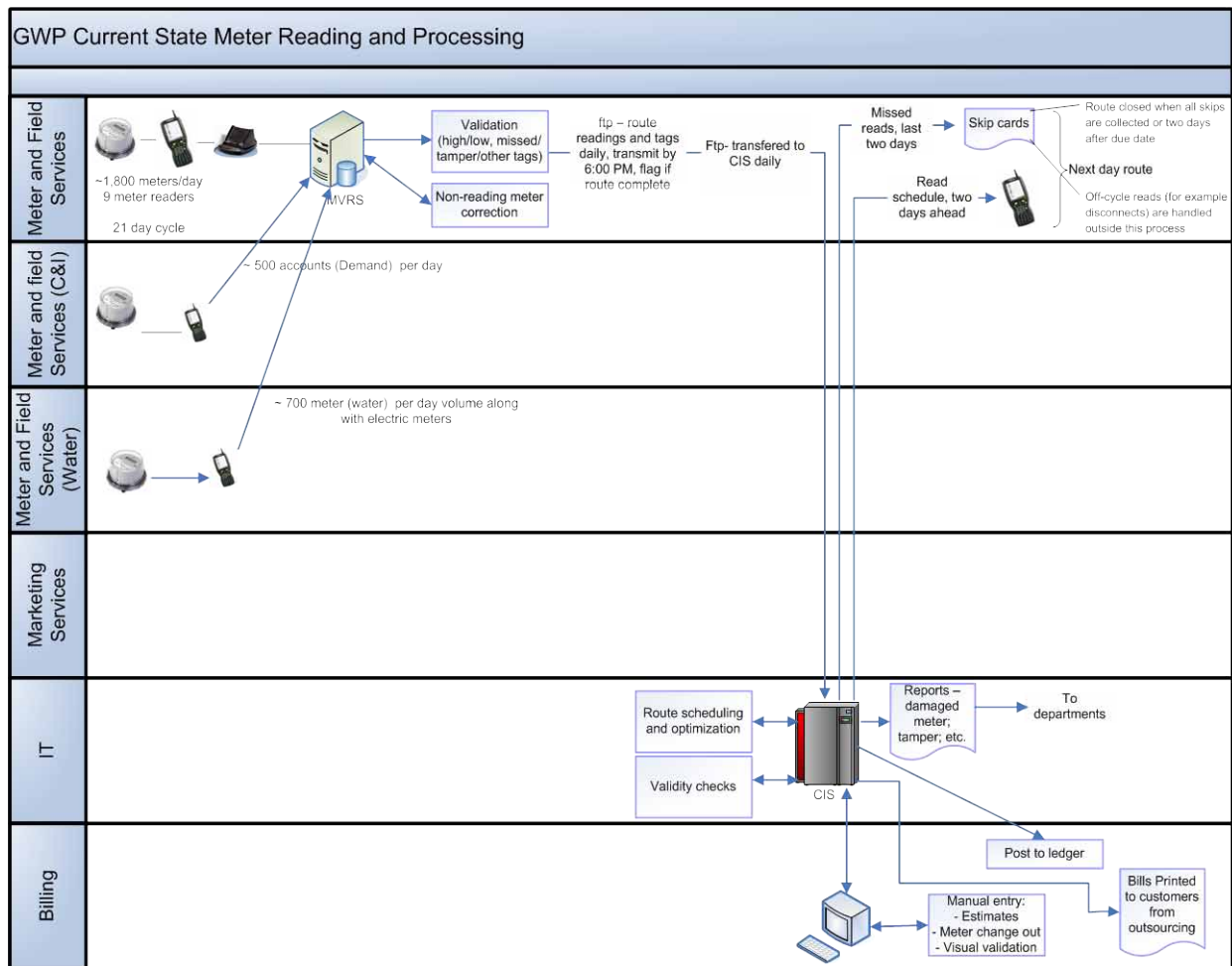
GWP has installed 144 dark fibers at most of the substations (which are in process of currently being lit) linking nearly all substations, main offices and facilities. Substantial bandwidth remains available throughout the system, and could be used to backhaul meter data from substations. Connection to the fiber path is straightforward, and both Ethernet and Sonet technology can be supported. The Electric Services department is in the process of lighting up fibers for SCADA needs. The Water Services department has their own SCADA which is managed by the Water Services department.

GWP has towers on the mountain top which are available for AMI purposes. Backhaul has to be T3 or T1 lines. The City of Glendale also has various buildings (half a dozen fire stations and half a dozen libraries) where antennas can be installed. Backhaul fiber from the City is also available for AMI use. GWP provides 24 fibers for City use and in return can use the City's existing fiber wherever practical at no cost.

There are about 10 people in the Information Services (IS) department. Customers can access the GWP web site to see their bill and conduct transactions.

The billing system has two full systems in a primary/backup configuration with nightly backups to hard disc and tape.

Exhibit 2-2, GWP Current State Meter Reading and Processing



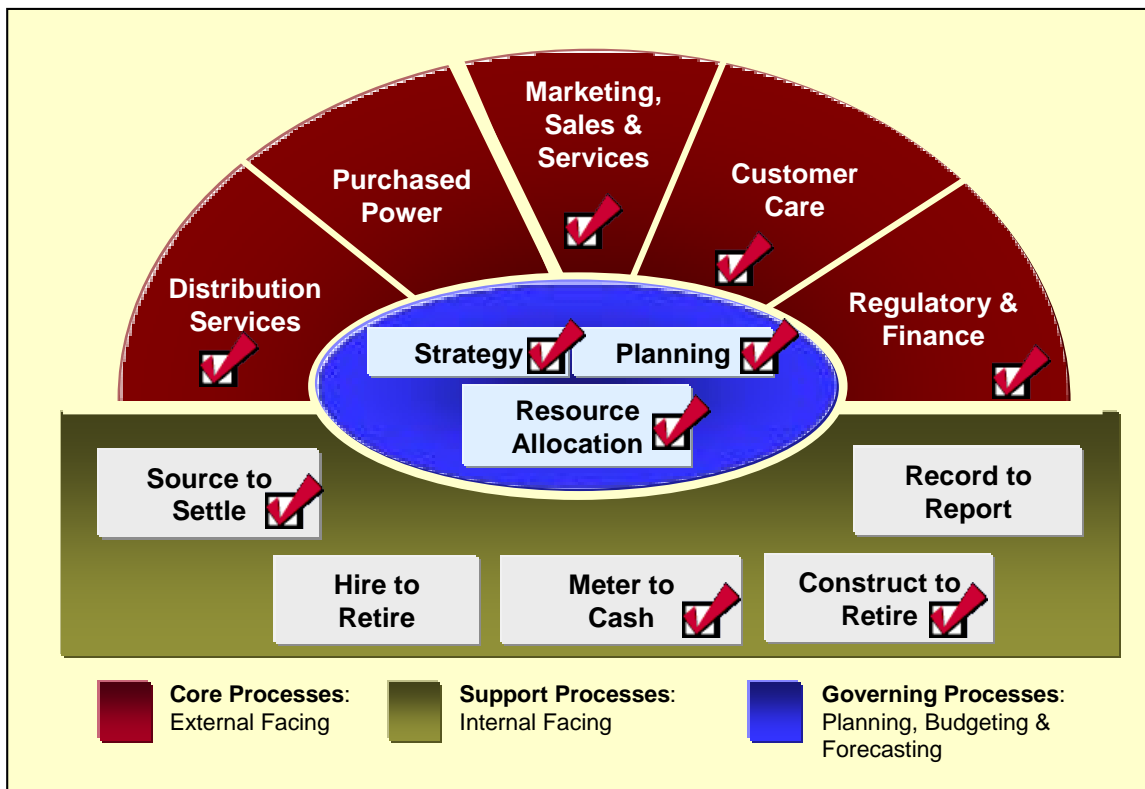
3. Strategic Alignment

This section presents the associations of meter data collection and processing with the typical processes within a generic electric power utility. The strategic goals, and objectives of GWP are then examined and the alignment of AMI functionality with GWP goals is presented.

3.1 Advanced Metering Association with Utility Processes

Meter data collection and processing, using both conventional and advanced (“smart”) meters, touches organizations and processes throughout a utility. Exhibit 3-1, Enterprise Process and AMI Associations, presents a map of processes within a generic utility. The associations of AMI functionality with the processes are indicated by checkmarks.

Exhibit 3-1: Enterprise Processes and AMI Association



Much of the AMI functionality is directed to the efficient collection of comprehensive power usage data and the transformation of the data into invoices. However, the less obvious benefits stem from the value of the data for more detailed monitoring of the power system in real time and more accurate planning information. These benefits allow a utility to optimize the design and operation of a power system such that it can be built to and operated at its design limits rather than by employing conservative design and

operating criteria. In addition, with better real-time information, disturbances can be more readily diagnosed, restorative action can be dispatched directly to the source, and restoration can be positively confirmed before the crews return from the scene.

3.2 GWP Strategic Goals and Objectives

GWP anticipates achieving the following goals and objectives by deploying AMI:

General Manager:

- Support Smart Grid (Grid of the Future)
 - Provide products to promote energy efficiency
 - Distributed Generation Management - Solar Energy
 - Support deployment of Plug-In Hybrid Vehicles
 - SCADA/GIS linkage
 - Outage Management
 - Water Conservation – Leak Detection
- Environmental Stewardship
 - Reduce Carbon Footprint (GHG e.g. AB32)
 - Real Time Pricing (Time of Use rate)
 - Promote Alternative Energy – Solar Energy
- Better System Visibility
 - Demand Control products to reduce peak demand
 - Manage and Control Home Appliances
 - Outage Management and Customer Interaction

Customer Services:

- Improve Customer Satisfaction
 - Fast Response to Questions regarding Utility Bills
 - Increased Customer Communication
- Manage Revenue Services
 - Remote Service Disconnect / Reconnect
 - Rapid Theft Detection
 - Whobill Resolution
- Offer Advanced Services
 - Provide Real-Time Energy/Water Use Information
 - Provide Monthly Billing and bill date selection
 - Proactive Outreach for Leak Detection & Usage
 - Outage Notification
 - Comparative Consumption Information

Power Management / Marketing:

- Provide Demand Response
 - Provide Load Management
 - Provide Demand Response / Demand Load Control
 - Enable Energy Saving
- Improve Compliance with Regulations and Legislation
 - Encourage Distributed Generation Management
 - Install Program Controlled Thermostat
- Offer New Programs

- Demand Control Products to Reduce Peak Demand
- Support deployment of Hybrid Electric Vehicles

Executive Analyst (Financial):

- Fiduciary Responsibility
 - Rapid Detection to Reduce Theft
 - Determination of Whobill Resolution
 - Provide Monthly Billing increase cash flow reduce float
 - Load profile data for rate study
- Cost Reduction
 - Remote Service Disconnect / Reconnect (water also)
 - Meter Reading

Electrical and Water Services:

- Improve Planning
 - Improve Distribution Planning Process:
 - Real-Time Data for Sub-Branch Load Distribution
 - Transformer Load Calculations
 - Enable Total Cost Management
- Ensure Reliability and Quality
 - Improve Operating Performance of Outage Response
 - Improve the Ability to Locate and Restore Distribution Faults and water leak (non customer-side)
 - (CAIDI and SAIFI)

- Power Quality Management (Volt changes)
- Water Backflow detection and Electric Reverse Flow
- Better Manage Assets
 - Ability to Manage Customer Side Distributed Generation
 - Accommodate Sub-metering (MDU)

Information Services:

- Optimize GWP IT Assets
 - Install Meter Data Management Systems (MDMS)
 - Link Meter Readings to Customer Information System and other operational systems
 - Provide Two Levels of Redundancy
 - Primary/Backup and Backup to Disc
 - Contract Outside Maintenance Support
- Support Business Needs
 - Provide Customer Information Web Site
 - Near Real-Time Display of Interval Data
 - Provide Data Source for Internal Operational Systems
 - Outage Management
 - Provide linkage for reverse flow
 - Demand response verification (M&V)
 - Ability to explore alternate demand charges

3.3 Advanced Metering Alignment with GWP Objectives and Goals

Advanced metering must support GWP’s goals and objectives and must align with GWP’s strategic direction.

Exhibit 3-2, AMI Alignment with GWP’s Goals, shows the alignment of AMI functionality with GWP’s goals. From this graphic, close alignment can be seen with the General Manager, Customer Services, Power Management/Marketing, and Electric and Water Operations goals and objectives. This is illustrated at the bottom of the graphic.

Exhibit 3-2: AMI Alignment with GWP Goals

		GWP Organizational Goals and Objectives															
		General Manager			Customer Services			Power Management / Marketing			Executive Analyst (Finance & Governance)		Electric & Water Operations			GWP Shared Services	
		Support Smart Grid	Reduce Carbon Footprint	Better System Visibility	Improve Customer Satisfaction	Manage Revenue Services	Offer Advanced Services	Provide Demand Response	Comply with State Initiatives	Offer New Programs	Revenue Assurance	Cost Reduction	Improve Planning	Ensure Reliability	Better Manage Assets	Leverage Web Services	Support Enterprise Apps
Advanced Metering Infrastructure	Interval Data/TOU	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Net Metering	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Load Profile	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Power Quality	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	System Monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Remote Dis/connect	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	On Demand Read	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Home Area Network	Equipment Monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Energy/Cost Display	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	DSM / DR	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Local Area Network	Asset Monitor	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	DA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Back Office	Advanced Billing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Data Synergy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Customer Portal	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Customer Communication	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Issue Alignment	Closely Aligned			Closely Aligned			Closely Aligned			Limited alignment		Closely Aligned			Good Alignment	

Legend:
 TOU – Time of use metering
 DSM – Demand side management
 DR – Demand Response
 DA – Distribution Automation

This exhibit shows that AMI closely aligns with the goals of GWP. In particular, deployment of AMI strongly supports:

- SmartGrid – by leveraging the pervasive communications network, advanced functions and monitoring of field assets can be used to provide critical information to manage the distribution network
- Better System and Customer Visibility - with access to timely information , GWP and customers will be able to better understand and respond to their needs
- Improve Customer Satisfaction – providing timely billing and usage information will benefit customers and the operations of GWP.
- Offering New Services – with access to timely and detailed information it is possible that GWP can offer advanced services such as proactive notification of excessive usage
- Improving reliability- AMI can enable GWP to more closely identify conditions, such as outage or transformer overload conditions that will help achieve a higher level of system reliability.
- Better manage assets – using the information obtained from the AMI system will allow GWP to better manage the equipment and services necessary to provide service to their customers.

Some of the key functionalities that unlock these benefits include the following capabilities:

- Time-of-use metering – both electric and water meters are capable of storing and transmitting interval information that can be used to develop time-sensitive or usage based rate programs.
- Service disconnect/reconnect relay – this functionality has become a standard offering in electric meters. This enables GWP to remotely remove or restore power. While the traditional use includes turn off for no payment, the relay can be used effectively to limit load. GWP can also use this with the appropriate back office service to implement prepaid energy services. The service connect relay also allows for better enforcement of and monitoring of move-in/out data which will substantially improve resolution of “whobill” issues.

- Remote asset monitoring through the meter – this capability unlocks distribution monitoring that would enable GWP to gather more timely and remote information from assets that are installed in the field.
- In-home energy display unit – this is a critical element that helps drive additional customer interaction and services.
- The communications capabilities facilitate better monitoring of power system devices, enhancing asset management.
- The back office functions enhance invoice preparation and facilitate access to billing data by customers and GWP customer service staff.

The teamwork, communications, and relationship issues are also addressed by AMI:

- The advanced meter functions promote interaction between GWP and its customers, allowing GWP to work proactively with its customers and for customers to provide feedback through better choices on electricity and water use.
- The home area network and demand side management are even better tools for two-way, real-time communications between GWP and its customers. Customers can make better-informed usage decisions and GWP can monitor their decisions in real time.
- The device management capabilities promote interaction between GWP and its customers by enabling control of customer devices to manage peak loads and control customer costs.
- Enhanced usage information can be added to bills to better inform customers of their energy usage.

Moreover, even though AMI aligns least with the organization issue, AMI still supports the organization:

- The advanced metering and asset monitoring capabilities provide a more complete view of the power and water systems promoting employee safety and effective management of the power and water systems.
- The service connect relay allows for disconnection of problem customers without exposing field staff to the, possibly abusive, customer. Eliminating field calls to disconnect and reconnect service enhances efficiency as staff can be directed to more suitable tasks.

- System planning is also enhanced with more information on current and historical operating conditions. The information to be realized from AMI includes per-phase power use, which can be used as input to power flow analysis to facilitate greater accuracy in predictive power system studies.

The enabling technologies of advanced metering that could be supported by these capabilities include:

- Advanced metering – allows for more sophisticated billing structures, such as time of use and prepay accounts.
- Service reconnection relay – Remote disconnect and restoration for move in-out (account start, end, or transfer) and for accounts prone to collections and slow payment history.
- Home area networks - enables in-home functionality such as energy data presentation and monitoring/control of major appliances, in support of time-of-day or demand response rate options.
- Device management – control customer devices for demand side management, in the absence of a home area network.
- Pervasive communications to the end point and to the back office – bidirectional communications carrying usage data from the customer to GWP, as well as:
 - Power outage indication, both to confirm disconnect commands and to notify operations of premise-level and limited-scale network outages.
 - Tamper indication indicates physical damage, removal/tilt, or other abnormal conditions of the meter and, in conjunction with the power outage indication, notifies operations of possible malicious activity.
 - Monitoring and control of distribution power system devices, such as capacitor banks (the device may not be metered, but the meter communications technology supports this capability).
- Back office systems – Meter Data Management systems can be specified to facilitate access to consumption information and real-time status across the enterprise and enable additional functionality and business functions.

In summary, a sufficiently-specified AMI system appears to be aligned with all aspects of GWP's objectives and goals. If a positive business case outcome is identified, AMI can facilitate the implementation of GWP's chosen strategic paths.

4. Future State

This section summarizes available AMI technology. Where technology is not applicable to GWP, it is so identified such that further investigation of the technology is not necessary. With the viable technology identified, a future state AMI architecture and process is developed.

The nominated future state meter reading and processing functions have been constructed following these guidelines:

- 1) Maximize the utilization of AMI technology to replace manual processes.
- 2) Retain existing technologies and systems that exhibit satisfactory performance where replacement is not necessary to optimize the benefit of the AMI technology.
- 3) Avoid technologies and designs that could impede the development of future functionality.
- 4) Avoid technologies that are not field proven or that are proprietary (available only from a single supplier).

Attachment 1, GWP Functional Requirements, to this report presents an analysis of the functional needs of AMI at GWP. Individual AMI functional characteristics are listed and a first-pass determination of applicability at GWP is indicated. The remainder of this section summarizes the functional analysis. The functional needs are preliminary and must be revisited during the specification and RFP phase should GWP proceed with AMI.

The following discussion of AMI technology is a snapshot of commonly available technology at the time of this consultancy. AMI suppliers are continuously seeking to improve existing technology performance and functionality. As these enhancements are made available or are proven to be effective in the market, it would be prudent for GWP to review the technology selections and scenario assumptions within the business case to ascertain potential changes to projected outcomes.

4.1 Meter Functionality

Meter functionality is rapidly converging across the suppliers to a “typical” set for residential and light commercial meters. The most common functionality (available from several suppliers) that may be of near-term interest to GWP includes (but is not limited to) the following general functions:

- 5) Interval recording of watt-hour usage, with non-volatile storage for several days to one month.

- 6) Interfaces to communications hardware (such as radios or power line carrier) or built-in (“under glass”) communications facilities.
 - a) Compatibility with emerging communications standards, including ANSI C12.22.
 - b) Remote download of meter firmware revisions and reprogramming commands.
- 7) Interfaces to devices at the site, such as:
 - a) Home area network interface.
 - b) In-premise customer displays.
 - c) Collection of gas and water consumption data as a contract service to other utilities.
 - d) Controllable end-use devices, such as electric water heaters, air conditioners.
- 8) Load disconnect switches, rated at 200 A. The switches optionally include:
 - a) The capability to limit current draw so that service can be turned off.
 - b) “Soft” turn-on, such that the service is immediately disconnected if a high current draw is sensed on the load side, upon the command to reconnect.
- 9) Notification of power outage conditions, with a short keep-alive capability (“last gasp”) to allow the meter to report for a few minutes after incoming power is lost. (This also allows a meter communicating via radio frequency (RF) to report if it has been removed from its socket.)
- 10) Tamper and theft notification.
- 11) Bi directional metering wherever alternative energy sources like Wind or Solar is installed.

This function set is similar for self-contained commercial and industrial meters:

- 12) Usage reading and storage, with additional capabilities for reactive power, power factor, multi-phase service, and power quality.
 - a) Bi-directional metering is available where distributed generation is installed.
- 13) Interfaces to communications facilities.

- 14) Interfaces to devices at the site:
 - a) Extended to include interfaces to customer energy control systems.
- 15) Notification of power outage conditions.
- 16) Tamper and theft notification.

The value of these capabilities to GWP must be evaluated within the context of the cost of the capability and the benefit, in terms of dollar payback and societal benefit. The business case presented in Section 5 of this report evaluates these capabilities and recommends beneficial functionality.

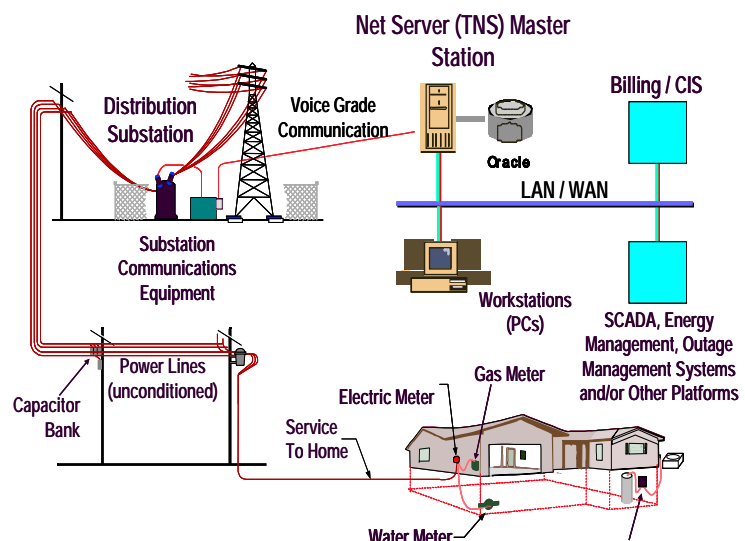
4.2 Local Area Network Communications

Reliable and sufficient (in terms of capacity) communications are key to the viability of the advanced meter capabilities. The benefits of many of the meter capabilities, in particular power outage notification, remote connect/disconnect, and remote download and reprogramming of meter or communications device firmware, would be limited or impractical without sufficient communications capacity.

Using the analogy of the electric power network, communications can be divided into transmission and distribution. The “local area” communications – communications from the end point to an intermediate collection point, such as a substation – are analogous to distribution. The wide area communications, from the intermediate point to the back office, are analogous to the transmission network. This section examines the local area communications. Wide area communications are examined in Section 4.3.

4.2.1 Power Line Carrier

This AMI system provides a medium speed (nominal 30 bits per second) communications network by connecting communication elements on the existing electrical distribution network. These elements include injectors and receptors that, and as their name implies, these devices insert and extract information on the electric service at key points within the distribution network. These elements are typically located the secondary-side of a distribution substation. Through these devices information including meter

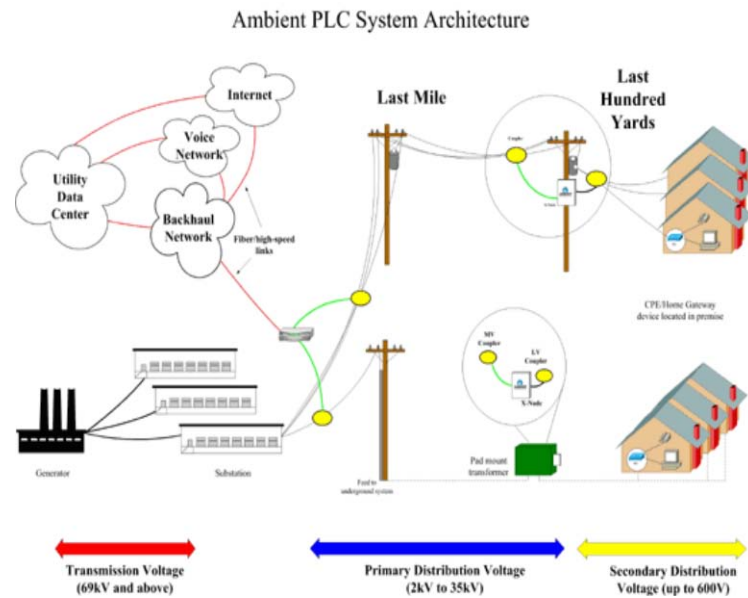


addressing signals is imposed on the voltage waveform. This information is then sent to all devices connected to this service feed. Meters contain a special decoding process that recognizes their address and information. The communications path from the meter to the substation equipment is accomplished using current modulation circuitry in the meter. This information is then extracted by the appropriate receiving equipment located at the substation. To enable communications with water meters or other devices that are not directly connected to the power line, a special radio transceiver can be included in the electric meter. This local radio relay link relays information from water meters or to or from thermostats. At the substation the PLC equipment is connected to a Wide Area Network (WAN) communications link that provides a backhaul to the back office. This WAN link can use traditional land-line, wireless, or other communications networks for communications.

The advantage of using the line frequency as a carrier is that the signaling can transgress the transformer secondary. While this would generally be adequate for remote meter reading, PLC throughput and performance is impaired or reduced by noise on the distribution system and has the real risk of interruption by outages on, or reconfiguration of, the feeder. Because of these uncertainties and the future-proofing of capability that AMI demands, PLC communications technology may not be most suitable for AMI deployment at GWP. This technology also requires costly hardware installation at substations to send and receive signals. As GWP's customer concentration is small, cost per end point will be quite high. With the concurrent acceptance of GWP, this technology was not included in the AMI business case.

4.2.2 Broadband over Power Line

This AMI approach uses a high speed (multiple Mbps) communications network that is overlaid on an existing electric network. It also uses a series of injectors and receptors to input and decode information that is carried over the power line similar to the PLC system described above. The high speed BPL network is generally based on Internet Protocols (IP) which would enable a number of addressable units to share the same infrastructure. The high bandwidth provided over the BPL can also be used for a number of devices and applications. Because of the high-speed data rates provided, the capacity permits a significant amount of information to be communicated with any given end point without significant delay.



Graphic source: Ambient Technologies

Broadband over power line (BPL) operates at a much higher data rate, with vendor claims of up to 10 megabits per second. The high speed is realized by installation of a series of repeater devices along the feeder to mitigate the deterioration of the high frequency signal along the conductor. Other devices are used to bridge transformers, since the transformers will not pass the high frequency signal. The network can be implemented such that reconfiguration of the feeder does not significantly degrade operation. However, there is an open debate on the viability of this technology and concern with large-scale deployment and interference with other RF signals, such as amateur radio.

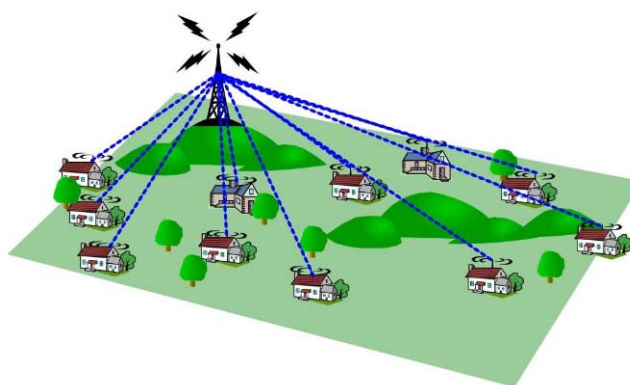
BPL is now in field trials with numerous pilot programs and early system deployments underway around the world. The relatively higher cost of BPL is also a concern, as a stand-alone option for AMI, as the installed cost of repeaters and bridges can be substantial. However, when considering the broader scope of potential distribution automation benefits that can be derived from the high bandwidth capabilities of BPL this technology could be of value to GWP.

The business case is focused on the immediate benefit to GWP. Cost per end point for BPL is much higher than other alternatives and is not considered a viable option for this business case.

4.2.3 RF Point to Point

This is an AMI radio system that communicates from a single point (a tower) to a multiplicity of end points. Frequently, this is configured either as a star (hub and spoke) or a tree (hub, spoke, and relay point). In this single tower to multi-point system, accessing an individual meter point can be done through addressing or multiplexing. For the backhaul communications between the tower and the back office, a different communications arrangement is normally used, and may include cellular digital networks, standard telephone, fiber optics or private data networks or any combinations thereof. A Point to Point (P2P) arrangement can be configured to use either FCC licensed frequencies or unlicensed frequencies.

With the licensed frequencies, the transmitter and receivers can use high power level (2 watts or more) between the tower and end points. The licensing arrangement secures the use of this spectrum exclusively by the license holder in a given territory. Because of the coverage and the reach provided by this arrangement, fewer towers would be required to cover a given geographic area. These towers are normally located on elevated antenna structures and are powered from electrical services provided at the base of the site. Relay points can be used to overcome obstacles such as mountains that could block the radio transmissions.



For P2P systems that use an unlicensed frequency band, the average signal strength used between the end points and the tower is limited by FCC rules¹. This is typically about 100 milliwatts or less. Also since the frequency is shared by many other users, such as cordless phones, microwave ovens and other consumer devices, techniques must be employed that allow multiple users to operate in this frequency band without interference. Among the most popular techniques used by AMI systems is use of spread-spectrum modulation.² Because the range between



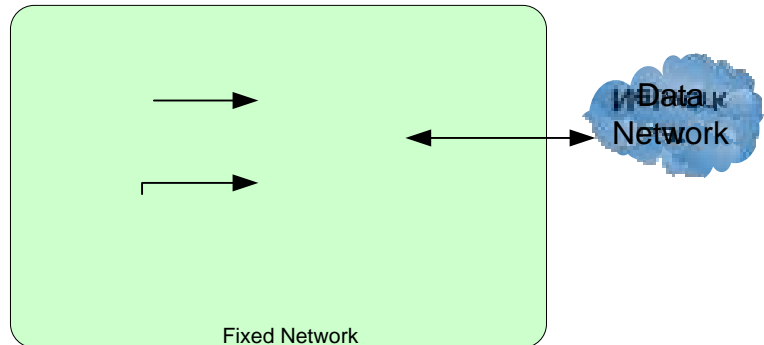
these towers and end points is limited to a few thousand feet, coverage would necessitate that more local towers are required to span the same geographic area as high powered systems. These “mini-towers” are traditionally mounted on utility pole-tops and obtain their powering from street light photoelectric socket adapters.

¹ FCC part 15 governs the maximum average power of these devices.

² Spread-spectrum uses an encryption algorithm that enables unique pairing of devices while sharing the same communication channels.

In some configurations of the low powered “pole-top” collection AMI system, the design configuration limits the communications from the collector to the end point in a “receive only” mode. In this case the collector can only gather information from nearby meters that it can “hear.”

The local collector has no capability to transmit unique information to a specific meter. However, since the collector to back office backhaul uses traditional data communications networks, the collector is able to transmit and receive information to



and from the back office. These systems have been called 1.5 or AMR+ systems. Although this approach does limit some of the integrated AMI functionality, a “virtual AMI” system can be configured by using an alternative communications network, such as a paging system, to link the back office to each specific service delivery point. Fixed radio network systems that provide full two-way communications to each meter point have greater feature potential. (Such as, ad hoc individual meter interrogation, query on power quality, communication with individual peripherals such as thermostats, etc.)

The installed cost of RF P2P depends on the number of end points (the meter radio cost is approximately the same as for other RF technologies) and the number of towers. The number of towers is generally dependant on the number of end points assigned to each radio (lower if higher data volumes are necessary) and topography (hilly terrain can cause dead spots). Repeaters can be deployed to overcome radio dead spots.

RF point-to-point can provide data rates up to 9600 bps. Assuming a maximum density of 30k end points per tower, RF P2P (at 9600 bps) would be suitable for low to medium data volumes, up to (for example) four-reading (on-peak, off-peak, shoulder, critical peak) collection. Higher periodicity reads, for example 5 to 15 minute interval usage data, could be accommodated by reducing the number of meters serviced by a radio (towers can carry multiple radios). Other channels are reserved for peak messages and events such as outages. However since the system uses a randomization technique (Aloha) this system could be swamped during large outages, where a large fraction of the meters would be attempting to simultaneously report loss of power.

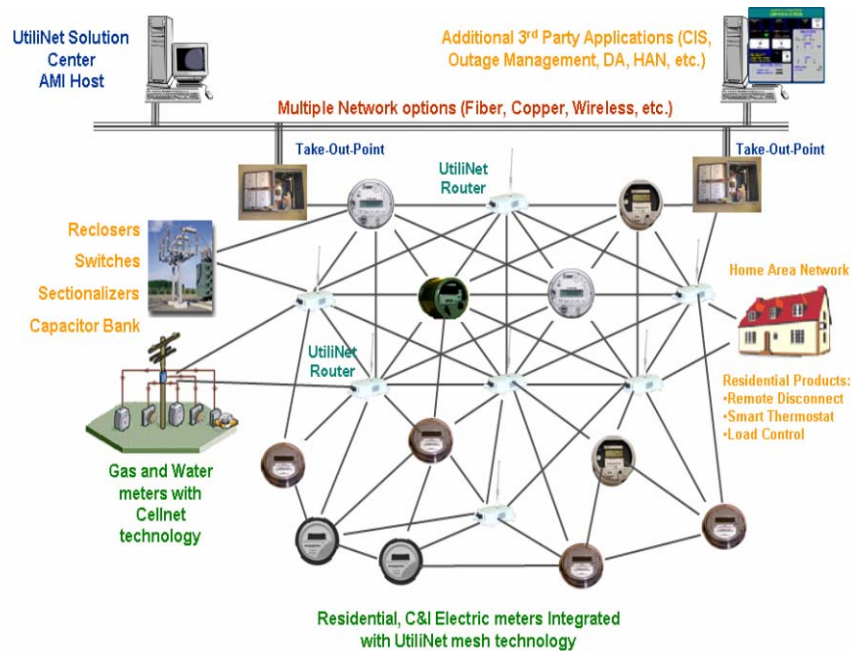
It may be possible to add RF P2P radios to existing Glendale city radio towers on existing towers on mountain tops. However, the towers are not conveniently located to access the GWP fiber network. This

report therefore assumes any RF P2P solution must employ new towers. For the purposes of this report, it has been assumed that all towers will be located at substations or city owned properties.³

Overall, RF P2P communications would represent a viable approach for GWP and will be examined further in the business case.

4.2.4 RF Mesh

This evolving technology system is similar to the arrangement that is described above since it also utilizes local pole-top collection units operating at low powered unlicensed frequencies. However, a key difference is that in a mesh network each end-point (or subset) has the ability to actively relay information from other points and to create a network among other end-points. This peer-to-peer network is used to optimize communication paths by re-routing or discovering the best path for each message through the network. It provides a level of robustness and alternate routing that improves the reliability of the communications. Meshing also reduces the total number of collectors and master station relay points (concentrators) that would normally be required by designating a few points in the mesh as a "take-out point."



Graphic Source: Cellnet

The installed cost of mesh radio is reasonable, depending on the number of end points (the meter radio cost is approximately the same as for other RF technologies) and the number of “take-out points” (analogous to the towers of an RF P2P system). The number of take out points is dependant on the number of end points assigned to the take out point (lower if higher data volumes are necessary).

³ Some communications technologies require towers over 200 feet in height, which may not be feasible to erect at substations. Other options in lieu of substation towers include towers at other sites and outsourcing the communications infrastructure to AMI suppliers, where carrier agreements may already be established. For the purposes of this business case, the substation tower option provides a reasonable proxy of the costs.

Intermediate “collectors” can be employed to bridge dead spots in the mesh (the radios are very low power and the meter “density” must be sufficient). While the number of end points per take-out point is typically less than that for RF P2P, the cost of a take-out point is significantly less than a radio tower.

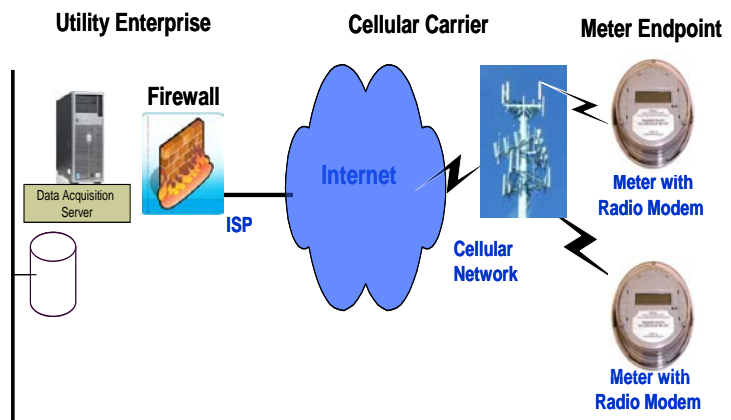
RF mesh can provide data rates up to 19.2 kbps. Assuming a maximum density of 5k end points per takeout point, mesh radio (at 9.6 kbps) is suitable for low to medium data volumes, up to (for example) four-reading (on-peak, off-peak, shoulder, critical peak) collection. Higher periodicity reads, for example 5 to 15 minute interval usage data, could be accommodated by using higher data rate radios (19.2 kbps) or by reducing the meter/take out point ratio. Careful design will avoid the overload problem where a large fraction of the meters attempt to simultaneously report loss of power.

Overall, RF mesh communications would represent a viable approach for GWP and will be examined further in the business case.

4.2.5 Telephone and Cellular

This is a medium speed (9600bps to 156,000 bps) AMI communication system that uses a "telephone-based" network (wired and wireless) to communicate with end points. These links can either be circuit-switched connections (session-duration links) or connection-less (packet-oriented) arrangements. These circuits are normally procured from a third party communications carrier such as Verizon, Cingular, or Sprint. A number of electric meter manufacturers have provisioned many of their meters with standard land-line modems (V.35 compatible) or as an option can include wireless modems that work with the major carrier systems. A number of vendors also offer an ancillary meter interface unit (MIU) that can connect to the serial data (RS-232) port of the meter.

Normally, carriers would apply an initial set-up fee and charge monthly recurring fee for use of these networks. This fee arrangement can either be volume-based on the amount of message traffic handled or it can be configured as a flat-rate fee that is independent of traffic volume. These systems can operate either in an originate (meter calls the master station) mode or a terminate (back office system calls the meter) mode, making these compatible with most utility interval data collection systems.



These systems can operate either in an originate (meter calls the master station) mode or a terminate (back office system calls the meter) mode, making these compatible with most utility interval data collection systems.

Telephone and cellular services have drawbacks. First, the usage charges are beyond the control of GWP. Services that would guarantee throughput by giving priority to GWP traffic over other traffic add a

premium. (Although power usage data is not very time critical and could be collected in low usage times, the power outage indication is more time critical.) Finally, cellular technology is changing rapidly and, although newer services trend towards faster and less expensive, the changeover can be costly and carriers will not guarantee service lifetimes beyond a few years.

Even with the drawbacks, cellular is often the default choice for communications with meters, towers, take out points, and other devices not readily accessible by other technologies. Cellular technology will be examined further in the business case, but only for use as the backhaul from the takeout points to the back office if fiber backhaul is not available.

4.3 Backhaul Communications

Backhaul or wide area communications carry the meter data from the intermediate points (tower or take out point, for example) to the back office. While some degree of latency (the delay in passing information from point to point in the communications network) is acceptable in the local area, low latency is more desirable in the backhaul. In addition, because the backhaul carries a higher data volume, higher bandwidth is desirable.

The GWP fiber system is considered for use in the backhaul path.

4.3.1 WiMax

WiMax is the next generation of the ubiquitous WiFi technology; designed for higher data transmission rates and wider range. WiMax has the advantage of being IP (Internet Protocol) based, simplifying its interface with the back office systems. WiMax operates at data rates of tens of Mbps, up to 70 Mbps in either direction.

The downside of WiMax is that it is not available in many locations and is currently being planned in only a small number of locations, typically large metropolitan areas. Moreover, as with cellular service, the usage charges could be costly, priority services may add costs, and the technology lifetime may not be guaranteed, as with any communications platform with limited usage.

The lack of existing and proven WiMax in the Glendale area makes this technology viable only in the future. It is not included in the business case.

4.3.2 GWP Fiber Network

GWP has developed a robust fiber optic network, linking its offices with nearly all of its substations. The fiber system has many desirable characteristics: it is owned and operated by GWP, eliminating the

problem of unplanned technology changes; the capacity and performance of the network exceed the needs of AMI by orders of magnitude; and costs are completely within the control of GWP.

The business case assumes the use of the GWP fiber system for backhaul communications where feasible; largely for towers and take out points located at substations. Cellular backhaul will be assumed for take out points not located at substations.

4.4 Meter Data Management

AMI systems can provide substantial additional meter data, such as the daily reporting of sub-hourly interval data from a large volume of customers, and these voluminous inputs must be efficiently and effectively processed, validated, stored and distributed. This is a requirement that is beyond the existing Customer Information System (CIS) and would necessitate that this function be managed by an appropriate front-end process. Assuming an MDM system can be designed such that the data passed to the CIS looks the same as the current implementation (an entirely reasonable assumption) investment in the CIS can be postponed until such time that other factors dictate redevelopment. (The anticipated implementation of time-of-use would be such a factor.)

An MDM would also provide the following features, which are not supported by any existing system at GWP or are supported by existing GWP systems incompletely or problematically:

- Registration and management of the meter inventory in a single system, including interfacing to GWP customer information and asset management systems. Meter inventory management would then be consolidated into a single system.
- Interfaces to multiple meter types, from different manufactures. Implementation of an MDM with the capability to communicate with multiple meter products and using open standards would preclude lock-in to a single meter product or product line.
- Interfaces to various communications media. As with the capability to support different meter types, flexibility of media interfaces will preclude early obsolescence and facilitate flexibility in the initial implementation and as new functionality is developed.
- VEE (verification, editing and estimating) functionality. Current MDM systems include rule-based VEE tools. Rather than develop customized software to process the raw readings, the MDM can consolidate and harmonize the VEE processing now performed across several platforms.
- Management of meter internal software, including download of updated software to the meters.

- Dissemination of information, including usage data, tamper indications, outage conditions, and other non-consumption related information, throughout the GWP IT domain.
- MDM system can host route optimization functionality.

MDM systems are available as commercial products from several providers. Careful specification and procurement of an MDM system will minimize customization of the functionality, such that future support of the system can leverage the large user community of the software supplier. Overall, an MDM system will consolidate functionality now implemented in multiple systems at GWP and will reduce work required to interface existing systems with the new AMI technology

The business case assumes that an MDM will be included in the solution.

Since an MDM can be sized to accommodate a significantly larger population of electric meters than is currently envisioned under normal organic growth, a potential business option may be to intentionally oversize this system to provide a “shared services” or “outsourced” service to other SCPPA members at a nominal fee. Although this new business opportunity would have minimal incremental costs to the economic business case of the GWP AMI plan, the benefits that could accrue by providing this service to others may be of further interest. Despite this business opportunity, a practical cost of a nominally sized MDM has been taken into consideration in the economic modeling effort.

4.5 Technology Lifetime

AMI technology has varied lifetimes. The servers for the MDM may be obsolete after three years of commissioning. Software is typically updated every two years. The meters and communications devices have longer lifetimes, perhaps fifteen years. The business case includes costs for maintaining hardware and software, as well as replacing defective meters, through the term of the case.

It must be noted that this maintenance will continue after the ten- or fifteen-year term of the business case. GWP must budget for upgrades, repair, and replacement of hardware and software through the lifetime of the technologies.

4.6 AMI Open Communication Standards

4.6.1 Local Area Network Communications

Currently the local area network is the area of greatest diversity of offerings. There is a movement toward ANSI C12.22; however, only a few vendors have fully implemented this standard.

ANSI (American National Standards Institute) is expected to vote soon on C12.22 as an open standard that, much like HTTP, provides an application layer standard for network communications. C12.22 is designed to transport standard data formats from electricity meters across any physical network medium. This open standard should improve integration and interoperability and be aimed predominately at the application level to allow for any communication medium to be used. It should be suitable for the data requirements and unique needs of the utility and allow for application growth not envisioned today.

Each endpoint in a C12.22-compliant AMI system, including the utility, is assigned an address. Meter data is communicated over the network with data packets. The sending device on the AMI network creates a data packet, and the AMI network delivers the data packet. Sending and receiving devices don't need to know or specify exactly how the AMI network delivers the data packet—whether by use of cellular communications, Wi-Fi, power line communications, or RF. The contents of the data packet are agnostic to the communications technology chosen.

Development of the C12.22 standard is meter data centric and makes full provision for system interoperability. The GWP Request for Proposal should specify the C12.22 standard.

4.6.2 Backhaul Communications

The backhaul communications system typically operates over standard IP networks provided by any number of means, including, but not limited to: Ethernet IEEE 802.3; GPRS/EDGE; CDMA, WiFi; WiMAX, or Fiber nodes.

4.6.3 Home Area Network (HAN) Communications

For the HAN, the emerging standard is the ZigBee Pro specification.

4.7 Future State Meter Reading and Processing

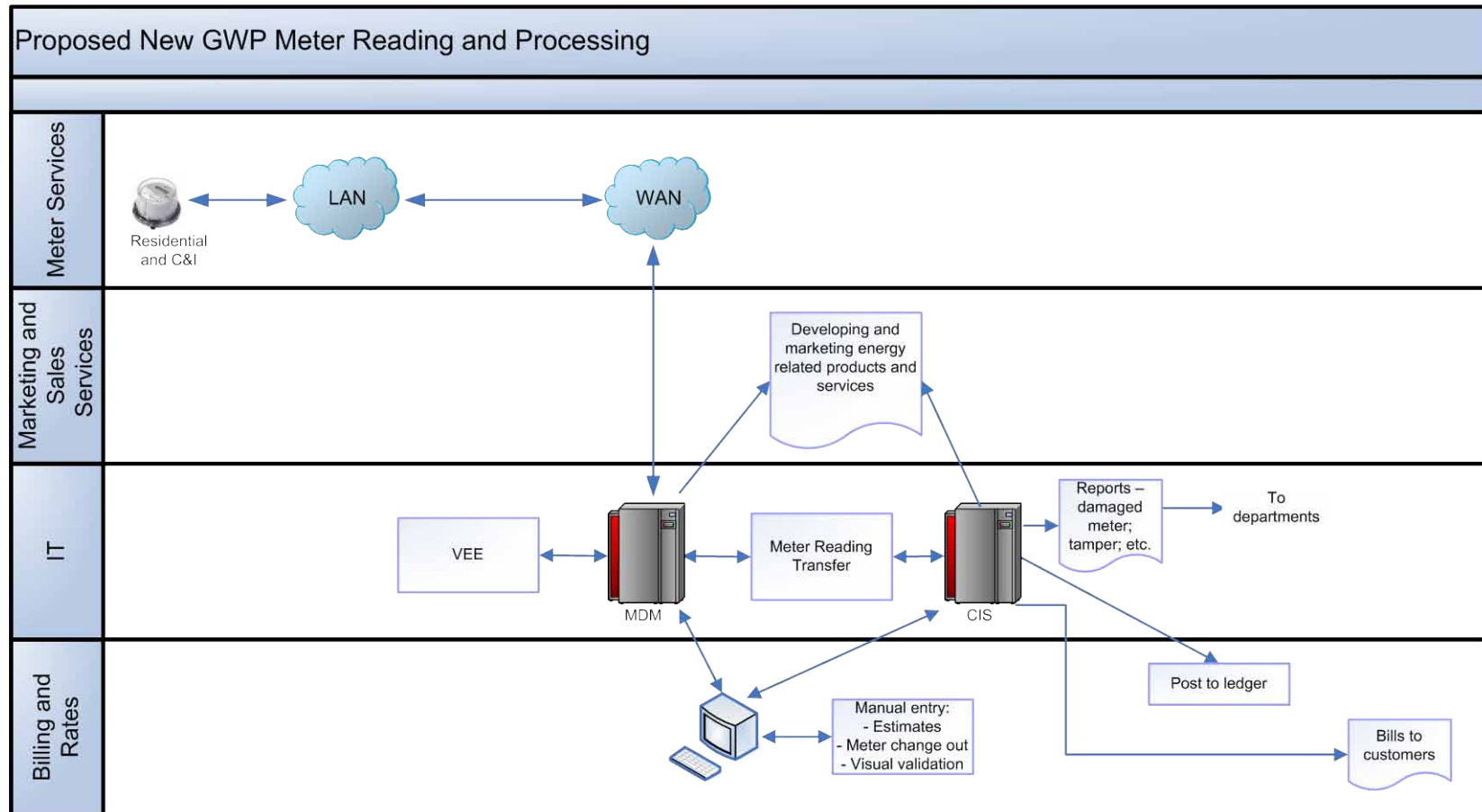
Figure 4-1 depicts the future state read to bill process. The process to generate the customer bills and to post to the corporate books remains as is. As discussed above, even though the CIS has limitations and may be redeveloped in the near future, the goal of the AMI implementation is to minimize changes to existing systems and processes unless changes are mandatory to implement AMI.

The front end meter reading processes will be almost entirely redeveloped. The meters will be read remotely using local and wide area networks to be developed as part of the AMI implementation. The communications will be bidirectional, such that the meters software can be maintained remotely and such that information on energy use could be downloaded to the customer premise. (Display of usage information to the customer requires display hardware at the premise – a home area network.)

The MDM will be implemented with an interface to the CIS as near to identical to the current interface between the MVRS as is practical. The MVRS may be included in the AMI system, depending on the meter and MDM purchased. Figure 4-1, Future State Meter Reading and Processing, shows the future state without the MVRS and the business case assumes the MVRS functionality will be included in the MDM system. This design will be revisited during the implementation phase.

The MDM may also take over other metering functions now performed in other systems, notably the meter inventory management and data validation, editing, and estimation processes. (Again, the details of the design can be finalized later.) The process diagram shows the Billing and Rates Section interface with both the new MDM and the existing CIS. This will likely be the implementation until the CIS is redeveloped.

Figure 4-1, Future State Meter Reading and Processing



5. Business Case and Financial Model

This section presents an analysis of the costs and benefits for the GWP smart metering plan. Costs considered both technology options discussed in Section 4. Benefits include tangible benefits to GWP, societal benefits and a discussion of strategic, non-quantified benefits.

5.1 Cost Analysis

KEMA's costing model for AMI projects includes benchmarks of meter procurement, communications procurement, IT procurement, installation, and program management. The data has been derived from publicly available information and data private to KEMA. The costs have been blended into average values and represent input from programs ranging in size from 40,000 meters to over 4 million meters.

Costs are estimated to a tolerance of $\pm 20\%$. Most of the error allowance represents volatilities in the marketplace, as the suppliers are currently bidding on or contracted to some large AMI projects. The ability of the marketplace to service all of the potential volume is unknown and meter prices could swing dramatically over the short term as suppliers' backlogs change.

In many cases, costs are presented as a cost per point (or cost per meter). Cost per point is a useful metric for comparing these costs as well as benchmarking this program against other AMI projects.

The costs presented below are estimated in fixed 2008 US dollars. The financial analysis evaluates the costs in terms of the time value of money. Exhibit 5-1 presents a summary of AMI costs, including both initial capital requirements and annual operating and maintenance expenses. The details of the costs are included with this report as Attachment 2, GWP AMI Financial Model. The cost details include information to identify the source of the estimation parameters and the assumptions made in developing the estimates.

The costs are predicated on supply and installation of approximately 83,500 electric meters, of which approximately 71,400 are single-phase, 200 ampere residential meters. The cost model also includes the cost for communications modules and installation labor for 30,193 water meters. Costs were developed for each of three communications options:

- 1) RF point-to-point (P2P).
- 2) RF Mesh radio (Mesh).
- 3) Broadband over power line (BPL).

The bottom line cost also includes a contingency of approximately 6%.

Exhibit 5-1, AMI Cost Summary

AMI COST SUMMARY			
<u>Cost Description</u>	<u>P2P</u> \$\$ (000)	<u>Mesh</u> \$\$ (000)	<u>BPL</u> \$\$ (000)
Meter Cost	\$ 16,071	\$ 16,881	\$ 14,862
Meter Installation	\$ 2,881	\$ 2,879	\$ 3,117
Total Meter Costs	\$ 18,952	\$ 19,760	\$ 17,979
Communications Cost	\$ 1,440	\$ 2,028	\$ 8,810
Back Office Costs	\$ 1,782	\$ 1,782	\$ 1,782
AMI Program Costs	\$ 1,862	\$ 1,862	\$ 1,862
Total Non-Meter Costs	\$ 5,083	\$ 5,671	\$ 12,453
Total Cash Outlay	\$ 24,035	\$ 25,431	\$ 30,432
Total Points	83,850	83,850	83,850
Overall Cost per Point	\$ 287	\$ 303	\$ 363

The summary clearly shows that the costs of purchasing and installing the electric meters comprise the bulk of the AMI costs, although communications for the BPL option are significantly higher.

The costs for RF P2P meters break down as follows:

- Residential, base meter purchase - \$60
- Commercial and industrial, base meter purchase – \$90 to \$230
- Under glass 200 A disconnect - \$40
- Home area network interface - \$15
- Assembly and inspection (by GWP) - \$4
- Installation, residential, standard/complex - \$24/\$36
- Installation, C&I, standard/complex - \$33/\$83

- Installation support, including workforce management, MDM data entry, customer care during installation, lease of staging areas, and tools - \$30

Overall cost per point for the RF P2P meters is \$287 per meter. The cost per point for RF mesh is slightly higher at \$303.

The cost per point for BPL meters is significantly higher, largely attributable to the cost of the base meter (higher communications hardware costs) and a costlier installation.

The business case assumes replacement of all meters, residential, C&I, and existing AMR meters. Benefits already realized from the C&I and the AMR meters have assumed to be part of the existing financials and have not been included in the benefits of this business case. This is the most conservative scenario. If, after selection of the meter and communications technology, any of the existing meters are compatible with the new communications and back office capabilities, they need not be replaced and the cost of the AMI implementation may be reduced.

While the costs for the P2P and mesh communications are essentially equal, the cost for BPL is substantially higher than the other technologies. The higher communications cost is entirely due to the need for hardware to frequently regenerate the data signal along the conductors and to bridge the signal around transformers. The potential benefit of BPL derives from its multi-megabit bandwidth (compared to a few tens of kilobits for RF technologies). The value of the benefit to GWP is examined later in this section.

Back office costs (IT procurement and commissioning) and program costs (project management and engineering, meter maintenance, and staff training) are a smaller cost component and are somewhat independent of the meter and communications technology.

5.2 Operational Benefit Analysis

KEMA's benefits model for AMI projects includes operational and societal benefits. The data has been derived from interviews with GWP staff and GWP financial documents. The results have been validated against benefits models from other KEMA projects.

Operational benefits are estimated to a tolerance of $\pm 20\%$. The operational benefits presented below are annual benefits estimated in fixed 2008 US dollars assuming the full benefit has been achieved. The financial analysis evaluates the benefits in terms of the time of accrual. Exhibit 5-2 presents a summary of AMI operational benefits. The details of the benefits are included with this report as Attachment 2, GWP AMI Financial Model. The benefit details include information to identify the source of the estimation parameters and the assumptions made in developing the estimates.

About half of the operational benefits derive from labor reductions of 18 full-time equivalents in the field services department for meter reading (normal, final, and special) and service disconnects and reconnects. The labor benefit calculation (for all departments) assumes the staff will be reassigned within GWP, and retraining costs are included in the business case.

The second significant benefit area is in increased revenue due primarily from the more accurate meter reads of the solid state meters for electric, and the ability to reduce system losses for water. For the water benefit case, no revenue increase benefits were taken because the costs for water meters were not considered in the model.

Other labor reductions are expected in meter services, billing and collections, and the call center. The meter services reductions accrue from having in-office access to data to evaluate zero reading and damage reports. In particular, zero readings will be reported daily, allowing timelier diagnosis of problems. Further labor reductions are realized by changes to the meter replacement program, as meter replacement can be performed when meters fail; operating meters can remain in service until failure. Labor reductions in the call center should be realized through both a reduction in the number of calls to investigate missed reads or estimated readings and through a reduction of call duration times, as the call center operator will have faster access to customer-specific data through the meter data management system.

The full labor reduction benefits are realized only by implementing AMI for residential customers. The benefits will be delayed if the C&I customers are converted to AMI prior to converting the residential accounts, since much of the infrastructure development costs must be spent even if a small number of advanced meters are installed.

It should also be noted that mesh radio may not function at full performance levels until a large number of meters are active. Mesh radio should be implemented by geographic area to achieve optimum performance levels, rather than by account type or size.

Capitol savings and non-labor operating savings accrue from retirement of vehicles and equipment in both the field services and meter services departments.

The revenue benefits derive from reductions in write-offs from inactive meters, more aggressive prosecution of theft, and higher accuracy of the meters. Inactive accounts can be disconnected and meter tampering is reported in real time.

Exhibit 5-2, AMI Operational Benefit Summary

AMI BENEFIT SUMMARY - OPERATIONAL STEADY STATE							
Description \$\$ (000)	O&M Savings		Capital Savings		Other		Total
	Labor	Non-Labor	Labor	Non-Labor	Revenue	Financing	
Field Services	\$ 1,148	\$ 139	\$ -	\$ 38	\$ -	\$ -	\$ 1,325
Meter Services	\$ 91	\$ 17	\$ 7	\$ 20	\$ 402	\$ -	\$ 538
Billing & Collection	\$ 93	\$ -	\$ -	\$ -	\$ 83	\$ 34	\$ 211
Call Center	\$ 150	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 150
Distribution Operations	\$ -	\$ -	\$ -	\$ -	\$ 657	\$ -	\$ 657
Total Benefits-Yearly	\$ 1,482	\$ 156	\$ 7	\$ 59	\$ 1,143	\$ 34	\$ 2,881
Total Points	83,850	83,850	83,850	83,850	83,850	83,850	83,850
Op Benefits per Point	\$ 18	\$ 2	\$ 0	\$ 1	\$ 14	\$ 0	\$ 34
Percent of Totals	51%	5%	0%	2%	40%	1%	100%
FTEs Included Above:							
Field Services	14.0		0.0				14.0
Meter Services	1.0		0.1				1.1
Billing & Collection	1.2		0.0				1.2
Call Center	1.8		0.0				1.8
Distribution Operations	0.1		0.0				0.1
Total FTEs	18.1		0.1				18.2

5.3 Societal Benefit Analysis

The data has been derived from interviews with GWP staff and GWP financial documents. The results have been validated against benefit models from other KEMA projects.

Societal benefits are defined (for the purposes of this business case) as benefits accruing from the voluntary actions of customers in response to demand programs instituted by GWP. Since GWP has not, as of the date of this report, developed such programs and since the customer response has not been studied (via a pilot program or other process), the societal benefits have been estimated by extraction and adaptation of the benefits from other, similar demand programs. The business case includes facilities to adjust the societal benefit parameters so that the benefits can be recalculated as the parameters become better known.

Exhibit 5-3 summarizes the societal benefits for a range of parameters, organized into a baseline and four optional cases. The costs presented are annual benefits estimated in fixed 2008 US dollars assuming the full benefit has been achieved. The financial analysis evaluates the benefits in terms of the time of

accrual. The benefits are derived assuming a cost differential between on-peak power intervals and low- and off-peak intervals.

Note that societal benefits result from conservation and peak shifting. Thus, they represent a reduction in revenue to GWP. However, the revenue reduction is offset by a lower cost of purchased power. The net is lower income, as the fixed costs of supplying power remain the same.

Exhibit 5-3, AMI Societal Benefit Summary

AMI Societal Benefit SUMMARY					
Benefit Description	Baseline	Option 1	Option 2	Option 3	Option 4
	\$\$ (000)	\$\$ (000)	\$\$ (000)	\$\$ (000)	\$\$ (000)
Load Shifting - Price Savings	\$ 43	\$ 543	\$ 336	\$ 499	\$ 664
Conservation - Usage Savings	\$ 732	\$ 1,097	\$ 824	\$ 915	\$ 1,006
Total TOU Programs	\$ 776	\$ 1,640	\$ 1,159	\$ 1,414	\$ 1,670
Peak Energy Benefits	\$ 2	\$ 7	\$ 4	\$ 5	\$ 8
Peak Capacity Benefits	\$ 36	\$ 797	\$ 718	\$ 907	\$ 1,097
Total CPP Programs	\$ 37	\$ 804	\$ 722	\$ 912	\$ 1,105
Total Other Benefits - Environmental	\$ 12	\$ 12	\$ 13	\$ 13	\$ 13
Total Yearly Societal Benefits	\$ 825	\$ 2,457	\$ 1,894	\$ 2,338	\$ 2,787
Total Points	83,850	83,850	83,850	83,850	83,850
Overall Benefit per Point	\$ 10	\$ 29	\$ 23	\$ 28	\$ 33
Customer DR Program Participation	24,761	24,761	24,761	24,761	24,761
Overall Benefit per Customer	\$ 33	\$ 99	\$ 76	\$ 94	\$ 113

The details of the benefits are included with this report as Attachment 2, GWP AMI Financial Model. The benefit details include information to identify the source of the estimation parameters and the assumptions made in developing the estimates.

The baseline case represents a conservative estimate; essentially a minimum expectation of customer participation in conservation and peak demand reduction programs. Option 1 results from more aggressive participation, but assumes that only those customers with air conditioning will participate. Options 2 through 4 are increasingly aggressive cases, assuming all customers will participate. For purposes of the GWP business case, Option 3 was selected. This option provides a realistic scenario of the current customer base and the most likely demand response program that will be developed.

The analysis assumes that only residential and small commercial customers will participate in the programs.

5.4 Business Case and Financial Model

Exhibit 5-4 and Exhibit 5-5 present the dashboard of the business case and financial model for mesh RF communications. The case presented in the exhibits is a conservative case. The scenario parameters include a fifteen-year study period, a three-year installation period, option 3 (most realistic) societal benefits, complete redeployment of staff within GWP, and mesh communications technology. The result is positive only when societal benefits are included. The mesh technology has an internal rate of return of 8.08% and a net present value of \$5.53 million. The payback term is less than eleven years, with a positive cash flow appearing in 2013.

As discussed above, the bulk of the benefits are realized from reductions in the staff performing the meter reading and connect/disconnect work and revenue increase from improved meter device accuracy for electric, and system loss reduction for water. The scenario includes societal benefits.

The results for this scenario are slightly more positive if point-to-point RF communications are used, IRR of 9.35% and NPV of \$7.3M. The next section, however, describes why the mesh technology is desired for GWP, and recommended. The business case is negative – an IRR of -0.86% and an NPV of -\$9.2 million – if broadband over power line (BPL) communications are used.

Exhibit 5-4, Business Case Dashboard, page 1

Dashboard

STEP 1: Modify the assumptions in the green cells in order to model Program Scenarios

Project Analysis Period (Years): either 15 or 10 years

Project Start Date: use yrs 2009 - 2012 only Jan 2009 **Project End Date:** Dec-23

Non-Meter Installation Start Months After Project Start Apr-09

AMI Metering Installation Start - Commercial Months After Project Start Apr-09

AMI Metering Installation Start - Residential Months After Project Start Apr-09

Demand Response Start - Commercial Meter Install plus 12 months Apr-10

Demand Response Start - Residential Meter Install plus 12 months Apr-10

Operational Benefits Start - Commercial Meter Install plus 12 months Apr-10

Operational Benefits Start - Residential Meter Install plus 12 months Apr-10

Meter Replacement Schedule Years

Non-Meter Replacement Schedule (months) Months

Meter Failure Rates Percentage Rate Per Year

Meter Full Warranty Period Years After Meter Start

Meter Limited Warranty Period: Years After Full Warranty

STEP 2: Select the Strategic Scenario Options listed below

Strategic Scenario Options	
Select Demand Response Program Option	03
Select % Deployment of Disconnects (Cost)	100%
Select % Disconnect Benefits Attribution	100%
Select Regulatory Benefits Period (Years)	5
Select Implementation Preference Order	Res Com Same
Select Installation Redeployment Option	100%
Select Severance Option	0%
Select Program Attrition Rate Option	10%

STEP 3: Select the Benefit and / or Cost Options to include

STEP 4: Input the desired overall group sensitivity (if not 100%)

Project years 15

IRR	NPV
8.08%	\$ 5,531

Project Payback 10 years 6 mth(s)

Positive CF Date 2013

Exhibit 5-5, Business Case Dashboard, page 2

Benefit Options - Operations	Group Sensitivity	Total Benefit (Cum. No Discount)	Memo: % Labor
<input checked="" type="checkbox"/> Field Services	100%	\$ 23,798	87%
<input checked="" type="checkbox"/> Meter Services	100%	\$ 2,835	58%
<input checked="" type="checkbox"/> Billing and Collection	100%	\$ 1,909	94%
<input checked="" type="checkbox"/> Call Center	100%	\$ 2,667	100%
<input checked="" type="checkbox"/> Distribution Operations	100%	\$ 692	0%
<input type="checkbox"/> Future Use 1	100%	\$ -	
<input type="checkbox"/> Future Use 2	100%	\$ -	
<input type="checkbox"/> Future Use 3	100%	\$ -	
<input type="checkbox"/> Future Use 4	100%	\$ -	
<input type="checkbox"/> Future Use 5	100%	\$ -	
<input type="checkbox"/> Future Use 6	100%	\$ -	

Benefit Options	Sensitivity	Total Benefit
<input checked="" type="checkbox"/> DR Load Shift and Conserve	100%	\$ 20,061
<input checked="" type="checkbox"/> DR CPP Energy and Capacity	100%	\$ 12,933
<input checked="" type="checkbox"/> DR Other Benefits	100%	\$ 179

Technology Cost Options	Sensitivity	Total Cost
<input checked="" type="checkbox"/> Mesh	100%	\$ (29,117)
<input type="checkbox"/> P2P	100%	\$ -
<input type="checkbox"/> BPL	100%	\$ -
<input checked="" type="checkbox"/> Back Office	100%	\$ (7,462)
<input checked="" type="checkbox"/> AMI Program	100%	\$ (10,360)
<input type="checkbox"/> Future Use 7	100%	\$ -
<input type="checkbox"/> Future Use 8	100%	\$ -
<input type="checkbox"/> Future Use 9	100%	\$ -
<input type="checkbox"/> Future Use 10	100%	\$ -
<input checked="" type="checkbox"/> Contingency	100%	\$ (140)

The business case allows GWP to study the AMI program with a wide range of parameters:

- The DR Program Inputs tab sets the parameters for the demand response (societal benefits) program.
- The Drivers tab facilitates sensitivity analysis of the key drivers of the business case. For example, the meter reading staff reductions can be varied and the sensitivity of the results to the changes can be seen directly on the tab.

The cash flow, income statement, cost-benefit summary, and depreciation can be viewed on the Financial Summary section of the business case.

6. Key Findings

This section highlights the key findings of the business case analysis.

6.1 Smart Grid Technology Assessment

One of the key directions for GWP smart metering is to be able to grow the system to support smart grid functionality well into the future. Typical smart grid applications take advantage of the communications infrastructure supporting the AMI application to monitor the state of the electric grid. These applications may include supporting outage management, fault detection, power quality monitoring, equipment condition monitoring, power flow analysis to support switching and load control, asset management and reliability engineering. These applications may require a broader bandwidth communications path than is typically provided in a RF point-to-point solution. For this reason, the mesh technology is recommended as the preferred approach to GWP's smart metering strategy.

Section 4 of this report described the technology differences between RF point-to-point and mesh. The mesh technology provides broader communications bandwidth than point-to-point. Also, in a mesh environment, physical areas of poor communications performance can be corrected by the addition of collectors. In a point-to-point environment, the addition of more RF towers does not improve the performance of the system because by design, the communications channels are limited to a narrow band.

Therefore, in order to ensure scalability and performance of the smart metering environment, the mesh technology is the recommended technology for GWP.

6.2 Strategy Alignment

The following summarizes some of the key alignment between the Smart Metering plan and GWP strategic business areas.

6.2.1 Strategy Alignment – System Reliability

System reliability is one of GWP's strategic areas as established in the corporate vision. As noted in Section 3 of this report. AMI can significantly contribute to achieving many of the goals set in these areas. The power system condition information provided by the meters and linked to GWP's outage management processes can facilitate diagnosis and restoration of normal operations.

Advancements in service disconnect relay performance and cost reductions make this meter function a viable option. While the primary result of this feature, as noted herein, is the reduction of costs associated with service disconnect and reconnection, this function can also provide an emergency contingency of selective area power removal to maintain system stability.

6.2.2 Strategic Alignment – Business Development

A second strategic goal of GWP is new business development. AMI can bring customers into the advanced energy information management age. Today there are many potential products that can be offered, including:

- Programmable communicating thermostats.
- Demand management programs.
- Energy watch-dog services (threshold monitoring).
- Flexible billing programs (move payment date once a year).

While these customer-facing opportunities represent possible new revenue channels, the largest business potential may come from providing AMI services to neighboring utilities.

As noted in the business case, the investment in AMI has many constituent parts: advanced meters; installation services associated with these devices; communication infrastructure; the deployment and operation of this network; back office information integration; data validation; and information management and content distribution. Each of these elements can represent possible areas that GWP may consider offering as a “service” to other smaller utilities that may lack the ability to perform these actions by themselves.

Other utility client programs might include:

- AMI buying programs (aggregate buying services).
- AMI advisory services, including benefit realization and business case assistance.

6.2.3 Optimize Resources

Automation is a key enabler to better apply technology to many labor-intensive processes; including meter reading and service disconnect/reconnect dispatches. While the project plan examines labor reduction possibilities in these areas, reallocation of the staff can help offset some of the risk of aging workforce staff loss and may mitigate some of the challenges of internal staffing needs of internal positions through effective training and transition management.

6.2.4 Empower Customers

Providing more information about energy usage and costs can help customers better manage their expenditures. Frequently, customers have little or no understanding about the effect of their usage on their overall energy costs. Whereas if information were presented in a manner more linked to the period of use, customers may have a better appreciation of how their personal patterns affect their costs, benefiting themselves, the community, and GWP.

6.2.5 Leverage GWP Infrastructure Investments

A key aspect of the possible technology implementation is that most of these infrastructures can leverage GWP's investment in fiber to the substations. This strategic asset helps reduce the recurring costs associated with procurement of commercial services which can have significant monthly recurring fees.

6.3 Strategic Benefits

In addition to the quantified benefits included in the financial business case, KEMA has identified a number of strategic, non-quantified benefits to the smart grid implementation. They are summarized in Exhibit 6-1, Strategic Benefits.

Exhibit 6-1, Strategic Benefits

Strategic Benefits	Area	Description
Support Real Time Switching	O&M Labor	Measure loads real time prior to execution of planned switching
Meter Route Maintenance	O&M Labor	Eliminate the need to maintain and continually update meter reading routes
Improved Customer Service		Better and timely consumption data, addressing high-bill complaints, usage history, ability to provide conservation advice, timely resolution of bills
Green Image		Improve the image of GWP as being "green" and doing the right environmental things
Cost of Meter Reader Injury	O&M	Eliminate costs associated with Meter Reader injuries and medical claims
Unregistered Meters	Revenue	Potential to find meters not currently tracked in CIS; also, potential to identify services that are not metered.
Single Premise Outage	O&M Labor	Potential to eliminate or significantly reduce the labor and expense to send a technician to verify a single premise outage when the meter is still energized.
Claims Due to Outages		Potential to reduce claims as a result of outages
Reduce Call Center Time	O&M Labor	Potential to reduce call center personnel time to call back customers to verify restoration of power.
Asset Management	Capital	Provides the ability to monitor overloaded transformers and proactively replace before failure; also monitor heavily loaded circuits and feeders. Monitor substation equipment for load and condition monitoring to avoid catastrophic failures.
Reliability Data	Capital	Provides more data on system loads and conditions for reliability analysis
Smart Grid Infrastructure	O&M	Provides the infrastructure to support a smart grid environment to allow remote sensing of circuit faults, switching and self healing grid.
More Customer Service Options		Ability to provide additional customer service options such as monthly billing, pre-pay service and level payment plans.
Demand Side Management		Ability to offer demand side management programs to customers (TOU, load monitoring and reduction)
Defer Capital Expansion Costs	Capital	Potential to defer or reduce capital expansion projects due to increasing load by slowing the rate of increase due to demand side management and conservation.
Green House Gases	O&M	Potential to reduce green house gases through reduced demand during peak loads
Monitor Distributed Generation		Ability to monitor distributed generation (DG, Solar, Wind) and measure power supplied to grid
Market Segmentation	Revenue	Potential to assess customer usage loads and patterns to provide targeted specific rates and service offerings (individual and customer segments) improving marketing cost efficiencies
Transformer Sizing	Capital	Improved load data will allow better and finer transformer sizing for new transformers, and the ability to swap transformers that are over sized to optimize use.
System Load Measurement	O&M Labor	Labor and equipment cost savings by not having to physically measure electric nodes and key points for load analysis.
Reduce Technical Losses	Revenue	Potential to develop distribution voltage monitoring capabilities and optimal control strategies for distribution system voltage and VAR control.

7. Recommendations

The financial model for the Advanced Meter Infrastructure produces a positive result under realistic and conservative parameters. The results remain positive for either the mesh and point-to-point technologies with societal benefits added. The benefit remains positive at the extremes of the estimation tolerances. The results are most sensitive to variations in the meter cost and staff reductions.

Based on the results of the model and technology assessment, KEMA recommends that GWP move forward with the following action.

- 1) Pursue the next stages to further the implementation of AMI.

The results of the financial analysis indicate that it would be wise for GWP to advance the progress of the study into action.

- 2) Use the business case and financial model to further review and examine the proposed work.

Where management or stakeholders have questions, the model can be employed to address these issues. And, once a project is established, the model input data can be updated and the project's financial viability can be reviewed as new data becomes available, particularly as proposals are received from technology and implementation suppliers with actual cost data.

- 3) Present this study to the Glendale City Council and seek their approval for a production deployment project.

Based on the financial information provided, GWP management should prepare a briefing and recommendation to the Glendale City Council. While there is some margin of uncertainty, taking action in key areas would help ensure a greater level of comfort and potential mitigation of risks.

- 4) Establish an AMI program.

Moving the effort from analysis into action will require dedication of staff and resources. While initially this effort may not require a significant dedication of staff, it is strategic that an "owner" is identified and empowered. This action would further commit GWP toward action and would help focus the organization to achieving the goals set forth. It would also establish the key "go-to" organization responsible for the execution and delivery.

Key steps in moving the program forward will include:

- a) Develop appropriate RFP documents and execute a procurement process.

It is essential that GWP issue appropriate procurement documents to solidify the cost estimates. AMI costs change continuously in reaction to market conditions. While this is largely good news, increasing lead times for the delivery of these systems as the industry demand increases are driving availability challenges.

GWP should issue these procurement documents based on the specific characteristics and business needs for the system. The results of this process will further refine the business case projection, open possible alternative approaches, and enable the suppliers who are interested in your business to detail the design requirements.

- b) Develop a detailed implementation and test plan.

There are many details that must be understood, assigned and managed to make an AMI program successful. Having an overall master plan that delineates the actions, timelines resource needs, interaction of activities and clearly establishes major milestones is an essential effort that is must be undertaken.