Automatic Meter Reading

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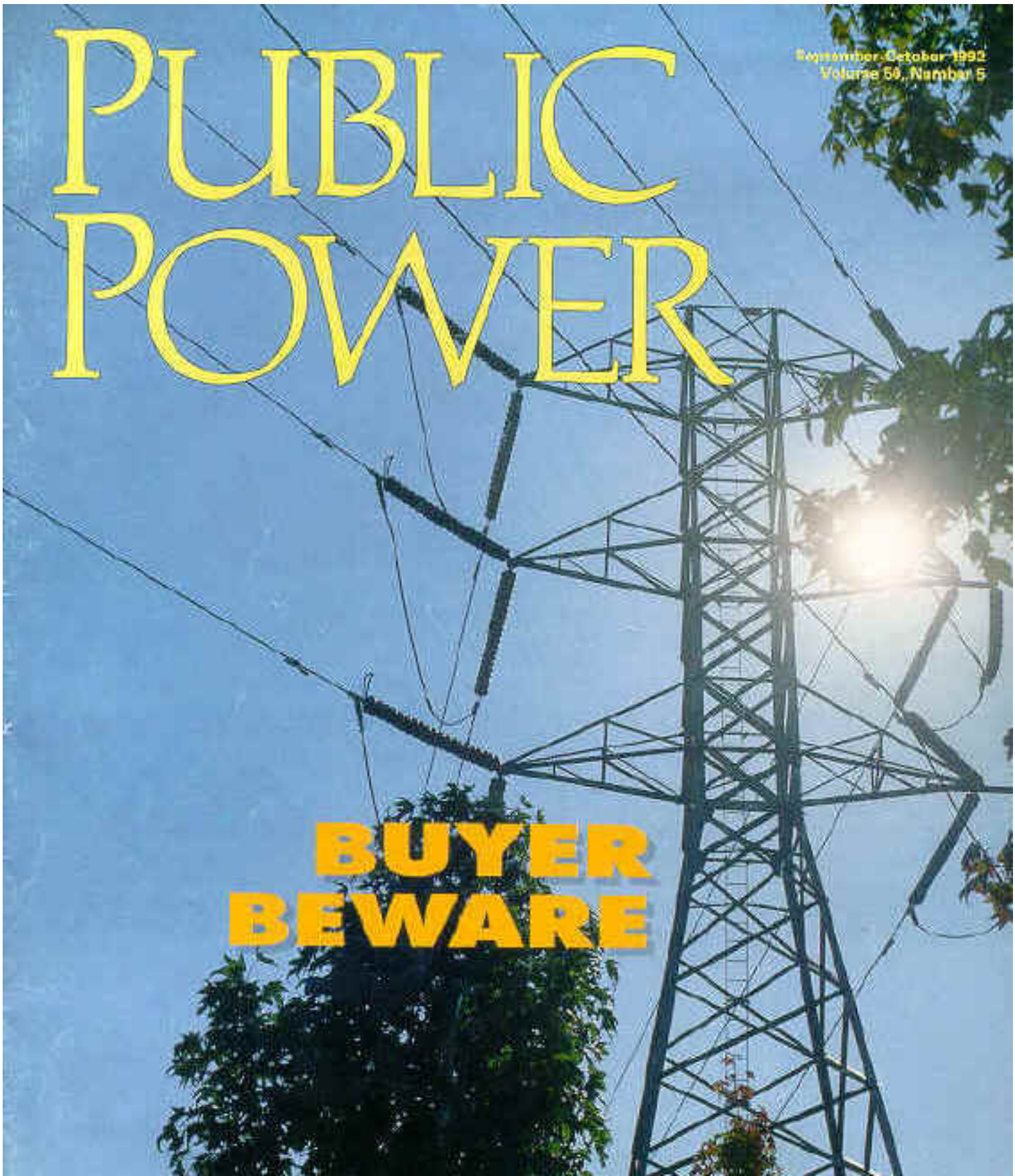

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Automatic meter reading (AMR) was first tested 30 years ago when trials were conducted by AT&T in cooperation with a group of utilities and Westinghouse. After those successful experiments, AT&T offered to provide phone system-based AMR services at $2 per meter. The price was four times more than the monthly cost of a person to read the mcter-50 cents. Thus the program was considered economically unfeasible.

The modern era of AMR began in 1985, when several major full-scale projects were implemented. Hackensack Water Co. and Equitable Gas Go. were the first to commit to full-scale implementation of AMR on water and gas meters, respectively. In 1986, Minnegasco initiated a 450,000-point radio-based AMR system. In 1987, Philadelphia Electric Co., faced with a large number of inaccessible meters, installed thousands of distribution line carrier AMR units to solve this problem. Thus, AMR is becoming more viable each day. Advances in solid-state electronics, microprocessor components and low-cost surface-mount technology assembly techniques have been the catalyst to produce reliable cost-effective products capable of providing the economic and human benefits that justify use of AMR systems on a large, if not full-scale, basis.

Automatic meter reading systems consist of three primary components:

1. **Meter interface module** with power supply, meter sensors, controlling electronics and a communication interface that allows data to be transmitted from this remote device to a central location. In many instances, this communication interface is bi-directional and allows central office signals to be received by the remote unit as well. Every electric, gas or water meter must have such an interface unit to be remotely read. Some key components of the remote device may be shared by more than one meter without regard for the type of meter; i.e.., electric, gas or water.

2. **Communications systems** used for the transmission, or telemetry, of data and control send signals between the meter interface units and the central office. Typically, such communications take the form of telephone, powerline carrier (plc), radio frequency (RF), or cable television. The system components in the communications system depend on the communication media used.

3. **Central office systems equipment** including modems, receivers, data concentrators, controllers, host upload links, and host computer. Many utilities have for some time been taking advantage of electronic meter reading systems using hand-held data terminals that communicate with a central controller via phone lines. There is great similarity between the host side electronic meter reading and automatic meter reading system function.

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There are three major building block functions that the meter interface and related electronics must perform. These are common to electric, gas and water implementations. First, an electromechanical or electro-optical interface must be incorporated into or attached to the meter. This converts information conveyed by the meter's mechanical register indexes, or dial readings, into electronic signals which may be processed, manipulated, stored and transmitted.

The second functional building block is a controller unit consisting of a low-voltage power supply, signal processing electronics, microcomputer, random access memory and program memory used to store the real-time run or operating system program. The controller unit is used to process the signals originating from the meter's electromechanical or electro-optical interface device. In effect, the controller unit converts the meter's electromechanical interface device signals into computer type electronic digital representations of the meter's exact index or dial readings-much as a calculator converts keypad entries into numbers appearing on the display. The controller's RAM memory maintains an up-to-the-minute mirror image of the meter's dials and as the dials increment, so do the numerical representations stored

in RAM.

metering data from the customer site to a central point.

The third functional building block is the communication scheme and its associated transmit/receive electronics. Generally, meter-to-utility host communications use one or more transmission techniques: telephone, powerline carrier, radio frequency through the airwaves, or television cable. There are many sub-categories of each of these communication forms having to do with data flow, modulation techniques, distance from remote site to central station and data transmission rates.

The AMR system starts at the meter. Some means of translating readings from rotating meter dials, or cyclometer style meter dials, into digital form is necessary in order to send digital metering data from the customer site to a central point. In most cases, the meter that is used in an AMR system is the same ordinary meter used for manual reading. The internal mechanism used for metering consumption is identical in both cases. The one difference is the addition of some device to generate pulses relating to the amount of consumption monitored, or generate an electronic, digital code that translates to the actual reading on the meter dials.

The four communication methods used for meter reading have various strengths and weaknesses.

Telephone lines -Telephone lines are desirable from an economic point of view since most electricity users in the country have telephone service. The telephone system provides an ideal communication infrastructure for AMR systems due to simplicity of operation, quality of data, high noise immunity, reliability and low cost, both at the remote site and the central station.

Telephone communications AMR systems are categorized by the method of call initiation and initial data flow. The two most common forms are inbound communications and outbound communications. With inbound communications, a unit at the customer site (usually the controller or a modem connected to the controller) dials in to the central station system at the utility without first receiving an interrogation message. The remote site unit initiates the communication at a date and time programmed into the controller's memory. In the case of tampering or system malfunctions, a call can be initiated to the utility's central station, where the alarm condition will be received and processed. This approach takes advantage of the fixed monthly charge for local calls that the customer is already paying. No additional telephone access equipment is required.

The disadvantages of inbound communications are that the utility cannot obtain real-time data upon request, nor can the utility reprogram the controller unit or issue control commands as in the case of connect-disconnect or energy management, should these capabilities be incorporated into the system.

Outbound communications arc those where data communications are initiated by a central unit located at the utility or at a local telephone company switching station. These systems respond to a query and require central telephone switching equipment and test trunk lines. Telephone company involvement is required to enable the utility's central station computer to dial out to a customer's remote unit without

ringing the customer's telephone. The advantage of this approach is that these systems function in real time, as needed, which simplifies the implementation of demand load recording surveys, status monitoring, etc. The primary disadvantages to an outbound communications approach are the capital costs associated with the telephone company's involvement and the recurring tariffs that telephone companies charge. An additional complication arises in geographical areas served by one electric utility and two or more telephone companies.

A third approach is termed bidirectional communications. In this case, communications are initiated from the remote site or the utility's central station. The advantages of both inbound and outbound communications are incorporated in this system design. In the majority of cases, the inbound function is used, thereby reducing telephone charges. Also, due to the decreased density of outbound traffic, telephone company switchgear and test trunk lines are minimized.

Powerline carrier -Powerline carrier communications take place over the same lines that deliver electricity. This technique involves injecting a high frequency AC carrier onto the powerline and modulating this carrier with data originating from the remote meter or central station. Years of research, however, have not overcome the technical problems that preclude this medium from being a cost-effective solution over primary transmission lines. Powerline carrier techniques may be used successfully and cost effectively for short distances; i.e., from a customer’s meter to a pole or surface-mounted transformer. It is very expensive to pass this data through a distribution transformer and onto the primary distribution lines and the resulting communications is slow due to the narrow bandwidth and mono-directional meaning data is transmitted from the meter to the utility but the utility can not send data or control signals back to the meter or associated devices at the subscriber side.

Radio frequency -Radio frequency, or RF, systems make use of small low power RF transmitters or transceivers located at the controller. These may take advantage of licensed or unlicensed portions of the RF spectrum and the effective radiated power of the transmitter and the distances capable of being traversed will vary as a function of the frequency and power of the remote transmitters and the receiving strategies employed. A variety of system configurations have been field tested thus far. The most successful employs a mobile unit operated in a van that sends a wakeup and transmit command to the remote meter units in its range. The remote meter units pick up the signal and respond by sending back requested data to the van's computer for later uploading and billing. This system is commercially available for use with gas meters. A variation of this approach employs remote meter units that regularly transmit every few seconds and a small portable receiver connected to a hand-held data terminal. Two of the more exotic approaches (in 1992) involves use of a cellular telephone network system and satellite communications.

The mobile receiver approach suffers the significant disadvantage of being effectively mono-directional; thus, communication cannot be initiated from the utility's central office. Therefore, systems of this type have limited function and relatively low feature/function cost ratios and are not well suited for use by electric utilities.

Cable television communication -This communication approach uses existing cable television lines to transmit data. Some tests have shown that this may be a cumbersome and expensive approach but some municipal utilities that own cable systems are undertaking this type of communication. Additionally, many installed cable systems are not configured to pass signals from the subscriber's site to a central facility. It is expensive to upgrade these systems with wide-band bidirectional amplifiers and subscriber interactive taps. Cable television should not be discounted, however, as a viable communications medium. Several municipal electric utilities have purchased their local cable companies and upgraded systems consistent with the needs of AMR. If these utilities sell AMR services to local gas and water utilities, this approach can prove very viable. Future advances in cable will include bi-directional digital signal transmission and much wider band width ultimately using fiber optics at which point cable will be an ideal communications medium.

The full-scale implementation of AMR requires that a data communication network be established that effectively links every utility customer with the utility's central office. The actual amount of AMR-related data and its frequency of transmission is very low. These factors contribute to the difficulties encountered in the economic justification of AMR systems. There are, however, a myriad of services and functions that can be accomplished through this communication system, some of which significantly reduce a utility's operating costs and some of which can actually generate additional revenues. The incremental costs associated with incorporating these functions in the AMR system controllers is marginal. Payback can vary enormously. In theory, it is almost possible to finance a full-scale AMR system installation through the resulting costs savings and new revenue-producing services. **Ten examples follow**:

- **Remote service connect and disconnect**-A recent survey indicated that the average annual turn-on and turn-off rate for electric utilities nationwide is 18 percent of total utility customers. Costs are incurred by sending a qualified service technician to a site to connect or disconnect a meter or power drop. With remote operation, these procedures are eliminated.
- **Energy management**-Indirect load control and direct load control offer a financially attractive alternative to increased production and delivery capacity.
- **Prepayment**-A number of utilities are investigating various prepayment systems. Such systems effectively eliminate collection problems and enhance cash flow.
- **Combining utility services**-The incremental cost associated with manufacturing a controller capable of receiving input from three or more meters is marginal. By the same token, data can be retrieved at the host end and segregated and partitioned with relative case and total security. By combining electric, gas and water AMR data on one system, the most expensive components-the communications infrastructure and the multitude of controllers-are shared by the utilities. Hence, the cost to each utility to go AMR systemwide is reduced to less than 40 percent of what it would otherwise be.
- **Submetering**-Multi-tenant properties can provide individual user data to the utility on a remote basis. The reduction of associated costs coupled with the magnitude of the transmitted information can, in many cases, allow the utility to offer its commercial customers new report-oriented services.

- **Customer display**,-Utilities can enhance customer relations by selling internal display units to customers that provide up-to-the-minute monitoring of power consumption, in dollars and cents. This can be used as an energy management tool and allows customers to verify and reconcile bills.
- **Security system and services**-A utility so inclined could have a central office security system data communication infrastructure in place. The controller could serve as the communications gateway and the utility could operate a security business directly and use its monthly mailing of bills for marketing, or it could simply provide the data, on a contract basis, to an outside security company.
- **Medical alert services**-As with security services, a utility could enter the rapidly expanding business of medical alert monitoring. The principles are the same as those for security services.
- **Intelligent building applications**-An area of overlap between intelligent buildings and the AMR system is customer information coupled with the variable rate structures. The AMR system can act as a specialized interface between the building and the outside world. Information regarding operations, prevailing rates, customer usage, etc., would be instrumental to intelligent building owners and operators. This information would be made available to the building's computer an-d could be displayed on wall-mounted units as well. Such displays of rate information have been tested by utilities for years.
- **Distribution automation and AM/FM**-Most utilities have begun computer-based mapping programs. By combining distribution automation and automated mapping systems and operating over the AMR network, any operational change occurring within the utility's equipment in the field can immediately be pinpointed on the computer based mapping system-a feature that greatly facilitates troubleshooting operations. When an outage occurs, data from the AMR and DA systems can be sent to the mapping system for immediate display as part of a geographical information map used for dispatching service personnel.

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Independent AMR Resource Sites:

themeterguy.com

USMeterReading/amr.html

History of Walk by & Drive by AMR

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