

## Central Virginia EC Taps IBEC to Advance BPL

*[CRN Executive Director Ed Torrero and Program Manager Andrew Cotter in November visited Central Virginia Electric Co-op, in Colleen, Va., to tour its broadband-over-powerline installation. Here is their trip report.]*

Four years ago, Central Virginia Electric Cooperative (CVEC) began working with International Broadband Electric Communications (IBEC), Huntsville, Ala., to explore if the company's new broadband-over-powerline (BPL) technology could deliver broadband Internet to its 33,000 consumer accounts across parts of 14 Virginia counties.

CVEC, headquartered in Colleen, Va., had determined that more than 90% of its members had no broadband option and that more than 50% of dial-up Internet users wanted broadband service.

Fixed wireless, DSL, and cable Internet providers found the economics insufficient to warrant extending service to most of the CVEC service territory, where consumer density averages about seven per mile. To co-op veterans, the experience reminded them of the reasons rural electrification proceeded as it did seven decades ago.

### Co-ops Receive Next Generation of Equipment

In the first step, an RUS-backed pilot program encompassed three co-ops—CVEC, South Central Indiana REMC, and Cullman Electric Cooperative, all headquartered in Cullman, Ala. CVEC and South Central Indiana REMC have had paying consumers as part of their BPL pilot programs since 2004. All told, the IBEC pilots serve about 225 consumers over 120 miles of line. CVEC has about 50 consumers and South Central about 175, with the Alabama pilot serving as a technical pilot program with no paying consumers. Each system is managed from IBEC's Alabama base. At each co-op, high-speed broadband signals from a long-haul provider are terminated at a head-end, which can be deployed anywhere along the electrical distribution system, and connections are made at that point onto the medium-voltage electrical system for delivery of broadband to members over the co-op's distribution lines.

IBEC is currently upgrading the equipment for the existing members served from one substation and installing the upgraded equipment to reach new members served by a second substation. At CVEC, the new service will initially inject BPL onto a CVEC substation serving about 3,000 consumers, or about 10% of its membership. CVEC has more than 30 substations and a growing membership. Already about 1/4 of eligible members have signed up for the broadband service. At South Central Indiana REMC, an even higher fraction of eligible customers want to participate.

Other developers of BPL technology include Maryland-based Current Technologies and Massachusetts-based Ambient Corporation. Current Technologies has recently concluded a wholesale distribution agreement with DirectTV that will enable the satellite broadcaster to begin offering high-speed Internet and Voice over Internet Protocol (VoIP) services over Current's networks, which are currently under construction in Dallas-Fort Worth and Cincinnati. Ambient Corporation has deployments with Consolidated Edison, FirstEnergy Service Company, and Entergy Corporation. Both firms are pre-commercial and are focusing on urban markets. IBEC is exclusively focused on serving rural and underserved markets in partnership with electric co-ops.

### Success Using Regenerators

There are two major innovations that separate IBEC's BPL technologies from other BPL products. Chiefly, IBEC's newly developed networking protocol—which includes BPL regenerator spacing design rules, optimized signal regeneration, optimized noise filters, and automated system configuration—enables extended transmission of broadband signals with little effect on bandwidth. A visit to a test site seven miles (or 12 regenerators) away from the substation where the broadband signal originated showed speeds higher than 700 kbit/s. These results are a departure from what was found in CRN's BPL demonstration, where bandwidth dropped exponentially each time the signal was amplified. IBEC and CVEC report that a BPL circuit in excess of 11 miles is currently deployed at CVEC, making it the longest BPL circuit in use today.

Regeneration does affect latency—about 4-6 ms per regenerator and somewhat higher with increase circuit length and numbers of regenerators in the circuit. This latency is comparable to what was seen in CRN's BPL demonstrations. This time delay poses problems for some time-sensitive applications, such as VoIP and online video games, if the distances from injection point to consumer are sufficiently long. For those applications, with regenerators every half mile or so, latency tends to limit operating distances from an injection point to about 20 miles. Traditional applications such as Internet Access and SmartGrid applications will not be affected by this latency. With the new system design rules, these distances can be optimized with longer distances expected.

The second major IBEC innovation is the couplers used to inject BPL onto a powerline. A lightning arrestor doubles as a capacitive coupler for overhead lines (an inductive device is used for underground lines). In addition to being an inexpensive, off-the-shelf product familiar to co-op lineman, the latest version increases the available bandwidth to 80 MHz.

Other improvements include a new chip set, whose speed has been increased from 40 Mb/s to 200 Mb/s. IBEC claims that a 400 Mb/s chip is expected next year. However, as with all such circuits, system parasitics and networking protocols typically lop off 50% of the speed, so only about 100 Mb/s of bandwidth is currently available to co-op consumers.

Field equipment on poles are now “hang and go” as a part of the standardized networking protocol mentioned above. Qualified linemen without special telecommunications training can install the units, and the electronics then automatically configure the equipment within the network. IBEC’s regeneration equipment also includes a Wi-Fi network, providing wireless access to the utility’s network at any regenerator.

## **Costs and Lessons Learned**

The lion’s share of work is funded by a \$19.2 million RUS loan awarded to IBEC to advance broadband at the three cooperatives. IBEC has already received follow-up support from RUS to provide BPL to an additional 13 cooperatives.

For these deployments, the average cost of BPL at a co-op is \$7 million, but the system comes with no capital investment requirement from the co-op. IBEC’s business model works as follows: IBEC provides all equipment and acts as the full-service Internet Service Provider (ISP) handling all the monitoring, maintenance, operations, and customer service for the Internet service. The co-op provides the consumer base, marketing, and billing. The co-op is responsible for installation of the BPL equipment on the poles, and IBEC pays a maintenance fee to the co-op to maintain the equipment. The co-op receives a percentage of the revenue for Internet service, which is priced by IBEC to co-op members at \$29.95 per month for 256 kb/s service and \$89.95 a month for 3 MB/s service. The consumer also pays for a BPL access device, or modem, which is plugged into a power outlet and then connected by an Ethernet cable to the computer.

Delivering a system that is always on, or nearly so, is always a challenge. Occasional Internet outages have been one of the key lessons learned in the pilot. One of the major problems uncovered was electrical noise affecting the BPL equipment. A distribution system’s numerous sources of noise can affect BPL performance, principally by reducing the speed of broadband signals and interrupting operation. During the pilot program, CVEC linemen were sometimes obliged to go to poles where BPL components were installed to reboot the electronics—hardly a long-term solution. With the newest BPL equipment and lessons learned on isolating and mitigating noise, this is not expected to be necessary when full BPL system deployment begins.

CVEC will evaluate whether to proceed with a full deployment depending on how well the technology is able to “serve every consumer anywhere all the time,” or at least 90% of the time, according to the co-op. CVEC reports that its consumers, like most everywhere, tend to have zero tolerance for loss of service.

IBEC reports steady progress in improving overall performance and reducing maintenance needs. In place of the commercially-available components employed in the first phase, the company will be using a custom chip set to generate the broadband signals, as well as BPL couplers fabricated for IBEC on an exclusive basis by Cooper Power Systems. These manufacturing changes have improved IBEC’s quality control processes and system reliability, the company maintains.

In addition, new system design rules are helping to optimize the placement and use of various parts, resulting in faster equipment deployment and consistently better service.

When CVEC awarded IBEC a non-exclusive license to reach out to consumer-members, a key requirement was that BPL must not interfere with SCADA, AMR, or other systems on the lines. No such interference was observed, although ham radio operators watched closely and conducted their own testing to ensure that the system did not interfere with their own licensed transmissions. In the upgraded equipment, flexible frequency notching techniques are available to solve potential interference on all licensed ham radio bands in compliance with FCC regulations, and interference with ham radio as well as public service band frequencies is not expected to be a problem.

Further improvements are expected through the standardization of system components and protocols. IBEC participates in BPL standards-setting committees of the Institute of Electrical and Electronics Engineers (IEEE), as well as those of associations of amateur radio enthusiasts.

## **Business Model Aims at Rural Co-ops**

According to IBEC executives, its BPL technology makes the most sense in rural areas where there is no alternative broadband service. The “sweet spot” for IBEC’s BPL technology is between 8 and 15 meters per mile. Toward the higher end, competition from cable and DSL becomes pronounced. Recent studies done for IBEC have determined that there are almost 200 electric cooperatives that fall in this category. The company estimates payback in 3-5 years (assuming at least 30% of the co-op members sign up for the service).

IBEC managers also assert that their technology can also be deployed today at co-ops with an average consumer density as low as six per mile—the payback is just a bit longer. At this time, IBEC discourages BPL for co-ops averaging fewer than five consumers per mile, but continued technology advances and cost reductions may allow co-ops with smaller member densities to be served by BPL in the future.

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