New Hampshire Electric Cooperative

Load Management Developments Report

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I. INTRODUCTION

This report provides detailed information and findings from a residential load management research effort recently undertaken for the NH Electric Cooperative by GDS Associates, Inc.

Load Management is a Demand-Side Management (DSM) technique that the New Hampshire Electric Cooperative (NHEC or the "Co-op"), with NHPUC approval, has offered since 1993[1]. By means of radio-controlled switching, the Co-op is able to turn off, or control electric thermal storage and baseboard heaters and electric water heaters in the homes of participating members. NHEC members receive the benefits of lower bills through the off-peak Heating and Controlled Water Heating Rates[2]. Additionally, the Co-op (in the past) has been able to use the program to help maintain system reliability and keep costs down for its entire membership through multiple benefits associated with reducing system peaks[3].

As part of NHEC's Core Energy Efficiency Program Filing, dated February 27, 2002, and subsequent New Hampshire Public Utilities Commission (NHPUC) proceedings and Settlement Agreements in Docket No. DE 01-057, the Co-op has stated its plans to maintain and operate its existing Load Management infrastructure during the current program period (June 1, 2002 through December 31, 2003). In its February '02 filing, NHEC explained that it would not actively market the program to new participants, but instead would maintain the functionality of its existing control systems and "conduct a study to more fully understand how the Load Management program should evolve as a function of the changing transition and wholesale energy market." (Page 26) In response to NHPUC Staff Data Request Tech-033, as part of these proceedings, NHEC stated it would perform a study that would entail the following elements:[4]

1) Review of need-to-know developments in load management;
2) Study and describe new technologies and what they mean to NHEC members;
3) Profile suppliers, their products and their market positions;
4) Discuss supplier instability and what NHEC can do to protect itself; and
5) Highlight what has not changed and remains useful.

The remainder of this report provides detailed information and findings from GDS' load management research effort, in each of these five areas.

[1] NHEC has been offering an interruptible water-heating program since 1979.
[2] NHEC's standard water heating rates, as of 5/1/03 provide residential members with a 0.57 c/kWh (4.3%) savings compared with the Co-op's standard residential service rates for the 600 to 1000 kWh rate block. NHEC's Optional Storage Heating (OPH) Rate provides members with a 3.17c/kWh (24%) savings when compared with their standard residential service rates. OPH customers pay an additional $3 per month meter charge. [1]
[3] These benefits include: supporting local distribution system reliability; delaying potential costly system upgrade requirements; and providing load interruption capability to support the NE ISO in managing system-wide and regional system emergency situations. Quantification of these benefits is outside the scope of our current review.
[4] NHEC's response to Tech-033 included a 6th element ("Study NHEC's load management infrastructure and provide recommendations to ensure members can receive the maximum benefit from this important program.") As noted on page 20 of the 2004 Core New Hampshire Energy Efficiency Programs filing, submitted to the NHPUC on September 30, 2003 (Docket Number DE 03-169), final results from this element will be presented year-end 2004.

II. NEED-TO-KNOW DEVELOPMENTS IN LOAD MANAGEMENT

When performing research on need-to-know developments, GDS focused on three main areas:

(1) Recent changes and trends within the regional and national wholesale (and retail) energy markets due to electric industry restructuring - to provide some context within which load management options can be more effectively assessed.

(2) Evolving load management and demand response programs - with focus on how such programs may be working within the changing energy markets;

(3) NHEC-specific load management (demand response) activities – to narrow the focus towards Co-op issues and implications.

Information was collected on these topics primarily through secondary research mechanisms. In addition, data was obtained through attendance and participation at industry meetings, conferences and discussions with other local, regional and national experts on utility restructuring and demand response programs, including appropriate staff at the Co-op. Key sources are noted within the appropriate sections below and in footnotes or endnotes, where applicable. The following noteworthy developments were identified:

A. Regional and National Wholesale and Retail Energy Markets

- Over the past number of years, electric industry restructuring has been quite active in the Northeast, with nearly all nine states in the region having enacted legislation or issued regulatory orders that are clearing the way for competition to grow for a majority of electric energy consumers in these states. [2]

- Nationwide, as of February 2003, 24 states and the District of Columbia have either enacted enabling legislation or issued regulatory orders to implement retail access. [3]

- As a result of these ongoing and evolving industry restructuring activities (and the recent/historically significant black-out) issues regarding adequacy of power supplies and electric/transmission system reliability are capturing additional attention.

B. Load Management and Demand Response Programs[5]

- Interest in load management and demand response programs is growing, with recent emphasis on their value as a resource to stabilize wholesale energy prices by reducing load at times of peak demand.

- Load management and demand response programs are not new. But past programs were not designed to capture the true market value of the load reduction they provided to the system since the power they saved was typically based on the cost of production, or contractual demand charges, not a spot market price.

- These programs are now being viewed differently, and are being designed to recognize competitive market issues and related economic benefits as well as electric system efficiencies.

- In addition to traditional distribution utility companies, more players have entered, or are considering entering the load management program market including: Independent System Operators (ISOs), retail suppliers, and aggregators.

- Typical load management programs being offered at the electric utility level include a mix of voluntary load shedding initiatives by large commercial and industrial customers (where energy using equipment is cycled off or where on-site emergency generators are turned on to displace power that otherwise would have been supplied by the load serving utility), and direct load control of residential and small business customer end-uses (*i.e.*, heating and cooling loads, and water heaters). Similar programs, often designed and encouraged through regional ISOs, include these emergency load curtailment and voluntary demand response programs, and evolving real-time pricing programs (where tariffs are being designed to expose customers directly to real time price volatility in the wholesale power market). Energy efficiency programs, which target reductions in kWh usage, are also contributing to valuable peak load savings.

C. NHEC Load Management/Demand Response Activities

- The New Hampshire Electric Cooperative traditionally has been a winter peaking utility, with estimated total winter and summer demands of 162 and 129 MW, respectively.[5] This represents less than 1% of ISO-NE's estimated 22,000 MW winter and 25,000 MW summer peaks and approximately 6% of the state of New Hampshire's estimated system peak of 2,100 MW.[5][6]

[5] Load management programs (also referred to as demand response programs) are typically utility or ISO-sponsored interruptible programs that can be used to reduce individual, participating customer's electricity consumption during peak demand periods. Many of these programs call on participants to interrupt or shed load on short notice to reduce the chance of broader power outages that would impact a large number of customers.[4]

- The Co-op currently has a substantial existing load management infrastructure, including over 7,415 direct load control and interruption devices/accounts[6] with cumulative peak energy shaving capabilities totaling over 13 MW.[7] This represents more than 8% of the Co-op's winter system peak load, and is provided through interruption capabilities available from approximately 12% of NHEC's existing base of 61,000 residential members.[7]

- NHEC currently operates and maintains its load management assets for the following key purposes:
  - Help to promote the efficient use of energy for specific end-uses to keep energy costs down for participating members through special tariffs and lower rates offered for interruptible loads;
  - Control capacitor banks for both Var and voltage support to insure a stable distribution system;
  - Support local distribution system reliability and delay potential costly system upgrade requirements;
  - Help to keep wholesale delivery service charges lower on all NHEC member's electric bills by minimizing monthly peak kVA levels seen at the Co-op's wholesale delivery points; and
  - Provide load interruption capability to support the ISO in managing system-wide and regional system emergency situations.

- New technologies and applications are currently under consideration within the Co-op that could have implications on its existing load management infrastructure. More information on these technologies and potential impacts is presented in the next section of this report.

[6] NHEC's load management devices are used to control electric thermal storage heaters, traditional baseboard electric heat when a secondary heating source (dual fuel) is available, storage water heating units, and standard water heaters.

[7] Focus of NHEC's load management is with residential members, although a small number of the Co-op's commercial/industrial members also are providing some load interruption capabilities.

III. TECHNOLOGIES AND NHEC IMPLICATIONS

When performing research on load management program and control technologies and potential NHEC implications, GDS focused on four main areas:

(1) End-user based technologies;

(2) Switching and control technologies;

(3) Central command and dispatch technologies and related software; and

(4) Load management control system platform technologies (e.g., radio control, internet based, cellular, satellite).

Following is a summary of the various load management control technologies currently being used by the Co-op, and other potential technologies, along with a brief assessment regarding implications and applicability for future NHEC load management use.

A. End-Use Technologies

Technologies in this category represent controllable end-uses (*i.e.,* mainly space and water heating applications).

Currently being used by the Co-op[7]

- Electric Thermal Storage (ETS) units – are space heaters that use elements to charge thermal storage ceramic bricks and have high speed fans to discharge the stored heat (newer models are programmable and have on-board thermostats). Steffes "S", "200 series" and earlier Valliant units have been used. In total, 1,269 ETS heaters are currently in use within NHEC residential member locations. This represents approximately 2% of the Co-op's residential member base. ETS remains a viable residential end-use load management technology.

- Dual Fuel installations – consist of electric baseboard controlled units with manual back-up heating systems (wood, coal, pellet stoves, etc.) that can be relied on during times of controlled load interruptions. Installations may also include "freeze stats" which would bypass load interruption controls should temperatures in the home drop below 40 degrees if the manual back-up stove was not fired-up. 836 accounts (installations) are currently in the field. Since many homes use electric baseboard heat (and have supplemental sources) within the Co-op's territory, there remains a place for dual fuel systems in the Load Management Program.

- Standard Domestic Hot Water (DHW) units – are typical electric hot water tanks (for NHEC's load management program, tanks must be at least 40-gallons to be eligible for

load management control). There are 4,890 Co-op current accounts that use load management controls for DHW heating appliances. Domestic hot water remains a viable end-use for targeted load control and provides both winter and summer peak saving benefits.

- Storage Domestic Hot Water units – are similar to standard domestic hot water units, but require 80-gallon minimum storage tanks with load management control capabilities. There are currently 420 members participating in the Storage DHW program. Some of these participants are also using ETS or dual fuel program components.

Other technologies and end-uses not currently being used/targeted for LM by the Co-op

- Additional space and water heating technologies, including: radiant floor and ceiling systems (using heating cables or grey water in combination with sand or brick storage mass); electric plenum heaters (working off-peak, in conjunction with existing oil or gas/LP systems that would provide on-peak heating); and solar water heaters (integral collector storage tank systems, thermo-siphon systems, and active systems, all of which, although would not have load interruption capabilities, will use less electric energy and result in lower kW demands during system peaks). Given the specialty application nature of these technologies, it is unlikely that sufficient penetration would result in NHEC's service territory for their consideration as potential load management resources.

- High efficiency heat pump technologies (cold climate and geothermal) - In addition to their potential load interruption capabilities, these technologies will use less electric energy and have lower kW demands when providing heating and cooling and thus could result in additional reduced system peaks. NHEC has recently added these technologies as eligible energy efficiency program measures. As more operational experience is gained, their abilities to provide both winter and summer load interruption benefits should be carefully assessed.

- Cooling end-uses including central air conditioning, room air conditioners, and through-the-wall units - Controlling these cooling end-uses are typical targets for many summer peaking utilities through either remotely cycling units off or controlling thermostats that will increase unit temperature settings by 4 or more degrees, when necessary during times of system peak. Depending on the penetration of cooling end-uses in NHEC's territory, these technologies could be good candidates for summer peak load management control.

- Lighting and process end-uses – More appropriate within non-residential (*i.e.*, commercial and industrial) facilities, these end-uses can be shut off or reduced through central switching or voluntary actions when called upon by the local utility or ISO. Although NHEC's current load management program does not target commercial and industrial facilities, the potential exists for both summer and winter interruptible load opportunities through lighting and process end-uses.

- On-site generation – Again more appropriate at commercial and industrial facilities, load is removed from the utility grid during designated times and supplied instead by local generation from on-site units. Although not currently a target in NHEC's load management program, the potential exists for both summer and winter peak load reduction through on-site generator technologies.

B. Switching and Control Technologies

Technologies in this category represent switches and controls used both within NHEC member locations and on the distribution system or at Co-op substations.

Currently being used by the Co-op

- Scientific Atlanta Switches – mostly "205" switches with three relays (two 5-amp and one 30-amp) plus a 24 V DC driver. Allows for on/off switching control of up to three separate devices within a member's home. There are as many as 7,500 of these switches currently in the field. These switches remain standard equipment and are widely available for use by electric utilities throughout the region and nationally.

- Switch-based heating power interrupt (PI) panels – 4, 6, 8, and 12-circuit panels (95% manufactured by Electro Industries, some Steffes panels, and a few socket interrupters). There are 2,836 PI panels currently in place in the field. These devices can be used to automatically activate a load-shedding control function and/or a peak shaving generator (functioning as the receiver that handles the control signal from the meter to signify that a peak has been reached and activates, often through any number of power line carrier receivers, the shut off function at the attached load - whether it is a water heater, furnace, air conditioner, radiant heating, hot tub, etc.). Although NHEC does not currently use local automatic meter reading (AMR) metering data for load management, each of these different types of switches and controls can be programmed to operate within pre-determined loading parameters that can be calculated from AMR metering data available at the location. PI panels remain standard equipment and are widely available for use by electric utilities throughout the region and nationally. There are some newer models being introduced in the industry that are more advanced in their communication mediums and variety of control applications.

- Automatic Meter Reading (AMR) - There are approximately 1,300 AMR meters currently in the field at NHEC member locations. These installations rely on telephone lines to transmit members' billing data. Newer AMR technologies use several different communication mediums including power line carrier (PLC), radio and internet-based. Although the Co-op is not currently using AMR metering data for load management purposes, significant opportunities for application of this technology exist.

Other technologies not currently being used for LM by the Co-op

- Regulator/Capacitor Controls - Through the use of line capacitors and voltage regulators, power factor can be improved and voltage levels controlled in order to achieve better overall system efficiency during peak periods and emergency supply conditions. The system bus voltage can be reduced through the use of automatic voltage regulating relays on load tap changer (LTC) power transformers and step-voltage regulators. This practice is best suited to short duration use and the ability of the system to maintain the required voltage levels to consumers down-line. The technology advances in this area have been rapid. The wide variety of controls and communication mediums for controls allow these products to be adapted to any utility situation. These controls can be programmed onsite or remotely through the use of cellular, two-way radio, power line signals, and SCADA controls. Although NHEC does have this capability, this option is currently not being used for load management purposes. Also, future control of these voltage regulators may shift due to the fact that they may now be controlled through the new SCADA system rather than through NHEC's load management computer.

C. Central Command and Control Software and Technologies

The technologies used for the control and monitoring of Load Management, AMR and SCADA systems are typically located in a master computer room within the utility. Often, different types of software and computer programs are used to monitor and control each technology. There have been tremendous advances as far as these systems working in conjunction with one another in recent years. New advances in AMR technology allow the meter readings that are automatically acquired to be used by the Load Management Computer to signify the required switching of down-line devices. The Load Management Computer can also communicate in conjunction with the SCADA system in order to make decisions and carry out automated switching and control operations. Through the uses of these different technologies, better system control and efficiency can be achieved.

Currently being used by the Co-op

- NHEC's central load management control computer and software consists a personal computer running under the Microsoft Windows 95 operating system and applications software written by Scientific Atlanta. Real time KvA and Kvar telemetry data from the Co-op's delivery points are passed to the load management supervisor (LMS) computer by the SCADA system. Based on time of day schedules and telemetry value setpoints, control signals are sent to Scientific Atlanta control switches via leased phone lines to Scientific Atlanta (SA) Remote Transmitter Controllers at NHEC-owned VHF radio transmitter sites. The SA switches in turn control PI panels, and water heaters as well as distribution line capacitors, substation regulators and load tap changers (LTCs). Scientific Atlanta no longer provides direct support for these systems and software. Comverge Technologies, a spin off company from Scientific Atlanta, supports at least some of NHEC's existing equipment. Key elements of NHEC's load management

computer and related software and technologies, although aging, have long histories of reliable operation.

- Supervisory Control and Data Acquisition (SCADA) system - purchased in the Fall of 2001 from Advanced Control Systems (ACS). It includes hardware manufactured by Hewlett-Packard and applications software by ACS running under the UNIX operating system. Communications to 38 ACS Remote Terminal Units (RTUs) located in NHEC substations and at delivery points is done using leased frame relay circuits. The SCADA system collects delivery point data and transfers it to the LMS. It can also control the substation regulators and LTCs independently of the LMS. NHEC's current SCADA system is relatively new and well supported by ACS.

Other technologies and software systems not currently being used for LM by the Co-op

In addition to NHEC's existing Scientific Atlanta load control system and the recently purchased (Fall 2001) SCADA system, a number of other technologies and software systems are available which include utility wide load control capabilities. Following is a list of three such systems: [4]

- Cannon Technologies software and systems for electric utility remote metering, substation automation and load management including their "Load Management Supervisor (LMS) system that runs as part of a high end Energy Management System (EMS) designed to dispatch energy resources", and their "Yukon set of software for metering and managing demand on the distribution system";

- Power Measurement's ION® meters and ION Enterprise web-ready software provide real-time supervision and remote and aggregated load management functionality; and

- RETX's Load Management Dispatcher™ and Silicon Energy's Curtailment Manager which provide real-time management and monitoring of utility-directed load reduction programs.

Assessment of these and other individual systems and their associated load management features and capabilities would be needed before applicability for meeting specific NHEC load control needs could be determined.

D. System Platform Technologies

The Co-op currently utilizes a network of 8 individual operational tower sites and associated infrastructure that extends one-way VHF radio control signals throughout and well beyond NHEC service territory, providing coverage and accessibility to nearly 70% of the population areas across the entire state. Several different models of radios are used at these transmitter locations (mainly GE 100 Watt Rangr mobile, and 100 and 375 Watt Motorola Micor radios). Each of these transmitters is connected to a Scientific Atlanta radio transmitter controller (RTC-1032) device.

There are several additional communication mediums in use today to control and operate load management devices including: power line carrier (PLC) systems, internet based, cellular, and satellite. Along with the Co-op's current radio platform, these communications are important for both monitoring the electric distribution system and for active switching and control of end use devices. In addition, AMR technology can be (but is no currently) used to provide peak loading information to NHEC's central load management computer. The load management computer can then automate down-line power interrupting devices or work in conjunction with the SCADA system to achieve switching of system components. With the variety of communication mediums available today, each utility can find the technology best suited to meet their needs.

Many of the new radio and other system platform technologies have features that exceed the capabilities of NHEC's existing load control equipment and may not interface well with the Co-op's current load management program infrastructure. However, the average lifespan of a radio transmitter is approximately 10 to 15 years and all of this equipment (within NHEC's load management system) is older than that and no longer supported by the manufacturers. Although, for the most part, this radio equipment remains operational and currently provides the functionality and capabilities necessary for direct customer load control, given its current age and obsolescence, the ability for this equipment to continue to reliably interrupt and consistently control member loads is now in question.

IV.PROFILE OF SUPPLIERS, PRODUCTS AND MARKET POSITIONS

Following is a summary of the manufacturers and suppliers that are currently providing the Co-op with its load management equipment and infrastructure support technologies, along with a listing of their specific products and general market positions, grouped by the same four technology areas used in Section III above. This information was collected through a combination of secondary research sources (company web sites, marketing materials, etc.) and direct phone conversations with appropriate equipment manufacturer and/or distributor representatives.

A. Relevant End-Use Technologies

Electric Thermal Storage (ETS) Units

- Steffes Corporation
  - 3050 N. Highway 22, Dickenson, North Dakota, 58601-9413, 1-888-783-3337, www.steffes.com, Northeast Sales Manager - Dan Gaffney, 800-224-3769
  - A brief description of Steffe's ETS equipment was presented previously. Specific equipment currently being used by NHEC include:
    - ETS Heaters
      - 2002 115v fan, 240v element, Steffes man. #1902050
      - 2003 115v fan, 240v element, Steffes man. #1902052
      - 2004 115v fan, 240v element, Steffes man. #1902054
      - 2005 115v fan, 240v element, Steffes man. #1902056
    - Auto charge, Steffes man. #1302022
    - Remote outdoor sensor, Steffes man. #1302026
    - Control panel, Steffes man. #1302020
    - Mini receiver, Steffes man. #1302028
    - Remote room sensor – double, Steffes man. #1302041
    - Remote room sensor – triple, Steffes man. #1302042
  - The Steffes Corporation has been in business for well over 40 years. They have over 1 million ETS units and related systems in the field nationally (over 50 million internationally). Recent sales have declined somewhat due to competition from new central air conditioning units, however, they estimate controlling over 90% of the market for ETS systems. Approximately 70% of Steffes ETS customers are electric cooperatives, 15% investor owned utilities, 5 to 10% are municipal electric utilities and the rest (another 5 to 10%) are direct sales to residential home owners, small businesses, and large commercial and industrial customers. Steffes offers a 5-year warrantee and full time technical support on their ETS products and estimates a long and reliable useful life (approximately 20 years).

Dual Fuel Installations, Standard and Storage Water Heating Units

- Various equipment types and suppliers
  - Provided by local heating and plumbing contractors and stocked by local hardware stores, equipment supply houses, department stores and home warehouse stores.
  - Standard equipment in residential members' homes, providing space and water heating
  - Market position of individual manufacturers' equipment and ages of equipment varies. Equipment (including the NHEC-promoted Marathon water heater) is installed by members prior to, or upon failure of their existing units.

B. Relevant Switching and Control Technologies

Switches

- Comverge Technologies, Inc, 4497 Park drive, Norcross, GA 30093, www.comverge-tech.com, Application Engineer – Tom Lulewicz 973-360-2220
  - Scientific Atlanta switches and software – a brief description of these switches was presented previously. Specific equipment currently being used by NHEC includes the SA Radio control switch, Scientific DCU-S2000
  - Although Scientific Atlanta no longer provides direct support for these switches, Comverge Technologies, a spin off company from Scientific Atlanta, supports at least some of NHEC's existing equipment. Millions of these switches are in the field nationally and internationally and have been operating for over 35 years. Comverge estimates that a majority of the switches in the market are Scientific Atlanta switches. Cooperative, municipal and investor owned utilities are the company's largest customers.

Switch-based Heating Power Interrupt (PI) Panels

- Electro Industries, 2150 W. River Street, PO Box 538, Monticello, MN 55362, www.electromn.com, Sales Rep – Dean Hamel, 763-295-4138
  - A brief description of these PI panels was presented previously. Specific and related equipment currently being used by NHEC includes:
    - PI panel 6 circuit flush, Electro man. #PI-036B2UE
    - PI panel 6 circuit surface, Electro man. #PI-036B24E
    - PI panel 8 circuit surface, Electro man. #PI-038B24E
    - PI panel 12 circuit surface, Electro man. #PI-03TB24E
    - Remote relay 30 amp, Electro man. #ARK 1161
    - Socket extender, 100 amp, Electro man. #SE-102C29G
    - Socket extender, 160 amp, Electro man. #SE-162C29G
    - Current transformer switch, Electro man. #PI-031DYZO

- Freeze stat, 40 deg., normally closed, Electro man. #05134

- Electro Industries has been in business for over 20 years. They have thousands of panels currently operating in the field nationally. Recent sales have declined somewhat due to the market using less control products, however, they estimate controlling a majority of the market for PI panels. Approximately 50% of Electro Industries' customers are electric cooperatives, 10 to 15% investor owned utilities, 20 to 25% are municipal electric utilities and the rest (another 10 to 15 10%) are direct sales to electrical contractors and product distributors. Electro Industries provides a 3-year warranty and 2 years from the date of installation. Ten hours per day technical support is provided by phone and annual customer trainings and other online support is also provided. Electro Industries estimates a long useful life (approximately 35 years) and claims an excellent record for reliable performance.

C. Central Command and Control Software and Technologies

Current Computer and Software Manufacturers/Technologies

- Central load management control computer and software written by Scientific Atlanta, now partially supported by Comverge Technologies, Inc, (a Scientific Atlanta spin-off company), 4497 Park drive, Norcross, GA 30093, www.comverge-tech.com.
  - A brief description of this equipment was presented previously. Specific equipment and load management system components include:
    - Microsoft Windows 95 operating system and applications software (written by Scientific Atlanta)
    - Cisco routers 2600 and 1720 series
    - Port sharing devices
    - Terminal servers
    - HP 400 switch in phone room
    - Westronics RTU D20
  - As noted earlier, Scientific Atlanta no longer provides direct support for these systems and software. Comverge Technologies, a spin off company from Scientific Atlanta, supports at least some of NHEC's existing equipment. Key elements of NHEC's load management computer and related software (*i.e.*, Windows 95-based PC) and technologies (including Cisco routers and Westronics RTUs), although aging, have long histories of reliable operation. For example, Westronics has over 20,000 RTU units in the field internationally, many of which have been operating since 1989 and estimated useful lifetimes of over 25 years. PCs also have reliable, long-term operating lives even though the evolution of their underlying technologies and operating systems continue to reap newer features and innovations at an ever-increasing pace.

- Supervisory Control and Data Acquisition (SCADA) system
  - Advanced Control Systems, 2755 Northwoods Parkway, Norcross, GA, www.acsatlanta.com, with local representation from EDI, 50 Surrey Drive, Plymouth, MA 02360, Greg Diercks, 508-747-1455
  - A brief description of this equipment, purchased in the fall of 2001, was presented previously. Specific elements include:
    - Hardware manufactured by Hewlett-Packard
    - Applications software by ACS running under the UNIX operating system
  - ACS was founded in 1975 and has delivered over 500 SCADA systems and 9,000 remote terminal units to 400 customers since that time. Their primary customers are rural electric cooperatives and municipal electric utilities and other (investor-owned) utilities. Currently, ACS is one of the major suppliers of real-time information solutions in the US and they compete effectively with global corporations. They claim long, reliable useful system life and provide industry-recognized exemplary support and service (24x7) in areas including data integration, system installation, analysis and planning, system administration, education and training.

D. System Platform Technologies

Radio Platform Technologies

- The primary suppliers of radio equipment for NHEC's load management system have been Motorola. 9941 West Emerald Street, Boise, ID 83704, Sales (Eastern US and Canada) – Dick Martin 919-562-2279; General Electric and Scientific Atlanta have also been providers of radio equipment for the current NHEC load management system.
  - A brief description of this equipment was presented previously. Specific radio transmitter and associated elements include:
    - 375 Watt Motorola Micor Radios
    - 100 Watt Motorola MSR2000 Radios
    - 100 Watt GE Rangr Mobile Radios
    - Scientific Atlanta RTC-1032 Radio Transmitter Controllers
  - Motorola and GE are market leaders in radio transmitter and associated technologies. Their products come with solid manufacturer warrantees and technical support services are provided on a 24x7 basis. As noted previously however, all of NHEC's load management transmitters are obsolete and no longer supported by the manufacturers.

V. SUPPLIER INSTABILITY, RELATED EQUIPMENT ISSUES AND POTENTIAL NHEC PROTECTIVE ACTIONS

Product reliability and equipment support is of crucial importance given the significant implications associated with product maintenance and replacements in the event of failures. As such, the condition of specific NHEC load management equipment and the reputation and stability of load management equipment manufacturers and suppliers is paramount. Specific issues identified during our research is summarized below, along with some potential NHEC protective actions:

A. End-Use Technologies, Related Switches and Controls

- NHEC member's existing load management equipment and related switching and control devices currently in the field is getting old (in many cases, over 10 years) and continued functionality may be questionable.
    - NHEC protective actions:
        - Proper installation and operational verification at time of initial install is critical;
        - Routine monitoring and regular testing to ensure continued functionality; and
        - Replacement of faulty equipment where appropriate.

B. Central Command and Control Hardware, Software and Radio Control Technologies

- Scientific Atlanta no longer supports the Co-op's load management hardware and software systems.
    - NHEC protective action:
        - NHEC has maintained a relationship with Comverge Technologies, a spin-off Company from Scientific Atlanta, for support of at least some of their existing equipment.

- Critical Motorola and GE radio transmitters and associated equipment is obsolete and no longer supported by the manufacturers.
    - NHEC action – Conduct a thorough assessment of the continued usefulness of this equipment and consider replacing or updating key components. A brief summary of the status of specific items is presented below by transmitter location[7]:
        - Colebrook - 100 Watt GE Rangr mobile radio. This radio is operational and the age of this equipment is about 15 years.
        - Conway District Office - 375 Watt Motorola Micor. There are actually two of these radios at this location, one is active and the other is a standby. The age of this equipment is about 20 years.

- Lincoln Sub - 100 Watt GE Rangr mobile radio. This radio is operational and the age of this equipment is about 15 years. There use to be a 375 Watt Motorola Micor at this site but that radio is now located in old Telco building, non-operational, status unknown. The age of this equipment is about 20 years.
- Mt Tecumseh - 100 Watt GE Rangr mobile radio. This radio is operational and the age of the equipment is about 15 years.
- Tenney Mtn - 375 Watt Motorola Micor. This radio is operational and is one of the oldest radios and is about 25 years old.
- Mt Belknap - 100 Watt Motorola MSR2000. This radio is operational and about 15 years old.
- Mt Kearsarge - 100 Watt Motorola MSR2000. This radio is operational and about 15 years old.
- Deerfield (formerly Chester) - 100 Watt GE Rangr mobile radio. This radio is operational and the age of this equipment is about 15 years old.
- Pulsifer Hill in Campton - 375 Watt Motorola Micor. This radio is not operational and the status of equipment is unknown. This radio is about 20 years old.

An earlier detailed Evaluation Report on NHEC's Standard Water Heater Load Control Program, conducted by Applied Resources Group, Inc., dated July 3, 1996, provided an assessment of the Co-op's then recently upgraded (January 1996) Scientific Atlanta master station and related systems. A number of issues regarding these systems were included in that report (see pages 23 and 24 of ARG's 7/1/96 report)[8]. Each of these issues is identified briefly below (see pages 29 and 30 of ARG's 7/1/96 report) [8]. NHEC protective actions that have been, or could be, taken are also presented where appropriate.

- Lack of reliable real-time load data from key delivery points.
  - NHEC action – all original Quantum meters at the delivery points have been upgraded with Nexus 1260 meters. Additional new delivery point equipment includes a 351R recloser control with a Beckwith regulator to feed a 2030 Data Concentrator.
- Limited communications data (just through hand-held tester) to ensure lines are functioning properly.
  - NHEC action – the Load Management Computer now receives all data from the new SCADA system via SCADA frame relay lines (phone lines are no longer used – therefore, proper functioning of these lines is no longer an issue).
- Potential for "over-control" due to unavailability of an application program to compute appropriate load control thresholds for key delivery points.
  - NHEC action – NHEC staff manually determine load thresholds above which load control would be invoked at each delivery point.
- Need for "back-up" (other than the "cold standby 486-based") system.
  - NHEC action – NHEC will be using its old Pilot system for "hot standby".

- Low staffing levels and potential impacts on continued reliable load management system operations.
    - NHEC action – currently, there is no backlog of work order requests relating to NHEC's load management system. Necessary manpower will still need to be assigned to resolve any future reliability issues.
- Limited access for NHEC member support staff to LM system information and display screens (no current link to Customer Information System - CIS)
    - NHEC action – ARG's report recommended consolidating load control participant databases and installing them onto NHEC's CIS System so that customer service personnel can easily access the member load control information when inquiries are made about their electric services. This has not been a priority, no action has been taken to date.
- Need for radio communication system statistics and quality checks to assess adequacy of coverage within NHEC's service territory.
    - NHEC action – ARG's report recommended completing installation of a monitoring system for all nine transmitters to ensure that the designated radio switches are successfully receiving signals. This has not been a priority and there are no current plans to do this.
- Need for formal system for the management of radio switch warranties
    - NHEC action – these radio switches are installed and maintained by NHEC's Energy Solutions department. Implementation of a formal warrantee management system has not been a priority.
- Potential need for remote console "to help the distribution operations dispatcher understand what is going on with management of his loads".
    - NHEC action – this is now being done through NHEC's SCADA system.

In addition to these items, to minimize other typical risks associated with critical load management equipment and potential supplier instability, the following general practices should also be followed:

- Purchase quality (utility-grade) products from reputable manufacturers and suppliers;
- Ensure products are backed with appropriate manufacturers' warranties and solid customer service capabilities;
- Where replacement parts are not immediately accessible, ensure an adequate supply of critical product elements are maintained in inventory;
- Carefully follow and document all manufacturer routine maintenance requirements;
- Develop, document and implement utility-specific testing protocols where applicable;
- Replace elements when needed to ensure continued full functionality of all critical load management devices and systems; and
- Communicate regularly with equipment suppliers/manufacturers and participating end-use members to ensure utility stays abreast of relevant changes in technology or equipment operational issues.

VI. HIGHLIGHTS OF UNCHANGED AND REMAINING USEFUL ELEMENTS

A high level review of the Co-op's current load management program and equipment infrastructure was conducted as part of this research effort, key elements of which were summarized in Section III above. The following elements of NHEC's existing load management program and equipment infrastructure are basically consistent with (unchanged from) current technologies. It appears that these elements will remain useful to the Co-op in future load management program implementation activities and will provide important benefits to participating members, all members at large, and the ISO-NE region during winter and summer peaks and at other times of system emergency.

A. End-Use Technologies and Related Switching and Control Devices

- Electric Thermal Storage (ETS) Units
  - These units remain a key end-use for load interruptions and will continue to provide important winter peak management and other benefits.
- Dual Fuel Installations
  - The ability to interrupt electric baseboard space heating loads though activation of backup heating sources in participating member locations remains important for NHEC, its member base, and the ISO during peaks and system emergencies.
- Standard and Storage Domestic Hot Water (DHW) Heaters
  - Control of these end-uses will provide both summer and winter load management benefits for the Co-op, its members and the ISO.
- Switches/Power Interrupt (PI) panels
  - Existing 205 switches and PI panels provide key functionality for performing actual interruptions. These items remain quite appropriate and are a critical part of NHEC's continued load management infrastructure.

B. Central Command and Control Systems and Radio Communication Technologies

The Scientific Atlanta software is a good match for NHEC's present Load Management program, but due to the lack of support for this product it may become inadequate for future programs.

Advanced Control Systems has a load management software package that can be added to the Co-op's current SCADA system. This software was designed to work with the SA205 switches and radio control platform that NHEC has in the field. Although the functionality of the standard ACS LMS package is not as flexible as the Scientific Atlanta software, ACS will customize their software for an additional fee.

NHEC's current radio transmission and associated equipment, although obsolete and no longer supported by the manufacturers, remains an important element of NHEC's load management control system. Given its current age and state of operability, continued reliance on these devices may become inadequate for future load control activities.

VII. NHEC'S CURRENT LOAD MANAGEMENT INFRASTRUCTURE AND RECOMMENDATIONS FOR FUTURE

A review of NHEC's current load management program and equipment infrastructure was conducted as part of this research effort. Key information from this review has been presented earlier in this report. A summary of the Co-op's previous and current load management paradigm and current load management infrastructure is presented below, followed by recommendations for potential future load management activities.

A. Original NHEC Load Management Paradigm

According to Company documentation, in 1993, the Co-op began to actively promote peak load management options to its membership, by means of radio-controlled switching. Promotion activities during the 1990's mainly included three load management programs: (1) the Controlled Standard and Storage Water Heating Program; (2) the Controlled Dual Fuel program; and (3) the Electric Thermal Storage (ETS) program. The importance of load management programs to the Co-op and its membership was clearly explained in an April 5, 1997 NHEC Tech Letter[8] as follows:

> "Load management is important due to the Co-op's long-term wholesale power requirements contract with Public Service Company of New Hampshire. Under [that] current agreement the Co-op is required to pay PSNH a "demand charge" based on the total monthly maximum demand at each of the 28 individual PSNH delivery points. This monthly maximum demand is compared to 70% of the highest monthly demand rate measured over the previous 11 months. The Co-op pays PSNH based on the greater of these peak demand numbers. The difference between actual peak demand and the 70% figure (if it is used in a particular month) is referred to as the "ratchet" charge. The Co-op's ability to manage and lower that peak demand at delivery points is critical. At [their] ratcheted delivery points, load control during the winter can affect monthly bills the rest of the year by lowering the ratchet peak. In this way, system-wide space and water heating control provides benefits all year long."

During the Co-op's active load management program promotion period, participants in the Off Peak Heating programs (Controlled Dual Fuel and ETS) received up to a 50% discount off the regular residential base rate for high usage (allowing the heating component of member's monthly bills to be cut substantially). Water heating control participants received a maximum of $18.78 per month discount based on usage.[9] Recent changes in the region's wholesale power

[8] NHECo-op Programs for Today and Tomorrow, Tech 5-2, dated April 5, 1997.
[9] NHECo-op Programs for Today and Tomorrow, Tech 5-4, dated April 5, 1997 (page 3). Subsequent NHECo-op Member letter on Standard Water Heater Control program identified a maximum monthly savings of $14.22. (no date)

markets, along with the Co-op's new energy (kWh) based "partial requirements" standard/default service power purchase contract, have resulted in a shift in this original paradigm.

B. Current Load Management Status

During the past 2 years, the Co-op's active promotion of load management programs has ended and bill savings to existing member participants has been significantly reduced (as reflected in recent tariff adjustments). The NHEC's current load management program focus has shifted to one of infrastructure maintenance, and is identified as an element of its utility-specific energy efficiency program offerings included in the Co-op's February 27, 2002 Core Programs filing with the NH PUC. As noted on page 26 of that filing:

> " NHEC plans to maintain and operate the existing Load Management infrastructure, but will not actively market the program to new participants."

Section III of this report provided more information (including brief descriptions) on the Co-op's current critical Load Management program elements.

C. Summary of NHEC's Current Load Management Infrastructure

As noted previously, NHEC has a substantial existing load management infrastructure, including 7,415 direct load control and interruption devices with cumulative peak energy shaving capabilities totaling over 13 MW. The following table provides a breakdown of this capability by end-use category:

NHEC Load Management Capabilities by Controlled End-Use Category

Controlled End-Use	KW Interruption Capability
Electric Thermal Storage Heaters (1,269@6kW)	7,614 kW
Dual Fuel Loads (836 units @ 2.8kW/unit)	2,341 kW
Storage Water Heaters (420 units @ 0.6kW/unit)	252 kW
Standard Water Heaters (4,890 @ 0.6kW/unit)	2,934 kW
Total Load Interruption Capability:	**13,141 kW**
Total Number of Members Controlled:	**7,415 Accounts[10]**

[10] Information based on number of installations as of 2001 (estimated kW savings from dual fuel installations could be less than 2.8 kW per installation)[7]. Some accounts include multiple units controlled within an individual member location (*i.e.*, ETS and Water Heat).

Nearly all of these devices control residential loads and represent over twelve percent (12%) of the Co-op's estimated 61,000 residential customer base, and more than 8% of NHEC's 162 MW winter system peak. For comparative purposes, according to a recent Peak Load Management Alliance report: [9] "Market studies have shown that substantial benefits may result from having relatively small amounts (e.g., 5% of peak demand) of demand response resources available." Given NHEC's existing load management infrastructure, it remains well positioned to achieve such benefits. In addition, NHEC's recent, and ongoing investments in infrastructure maintenance (summarized below) have helped to ensure continued and improved functionality of these important load management controls while assessing future directions and related automatic meter reading (AMR) options.

D. Recent NHEC Load Management Infrastructure Improvements

During recent years, including the past NHEC Load Management program period, a number of critical Load Management system infrastructure maintenance and improvement projects have been undertaken. Following are some brief highlights of these projects:

- All original Quantum meters at the delivery points have been upgraded with Nexus 1260 meters. These are only used to verify PSNH billing numbers at this time. The Nexus meters are not communicating with the SCADA system.

- The Load Management Computer now receives all data from the new SCADA system.[11] The SCADA system information is delivered by cable to the Load Management Computer's central processing unit (CPU). This required a cable to be run and a new program written so that the CPU identifies the data as coming from the old data concentrator. This is a one of a kind communication system that was developed at NHEC to save the members around $150,000 by not having to purchase new equipment and programs to do the same thing.

- New delivery point equipment includes a 351R recloser control with a Beckwith regulator to feed a 2030 data concentrator. There are currently 15 deliver points capable of communicating with the new SCADA system. The remaining 19 delivery points are awaiting 3 phase power connections to be activated. These are being addressed currently by NHEC's Engineering Department. The 2030 data concentrator takes the information and delivers it to the SCADA system by the frame relays feed. This ties to the system information being delivered by cable.

Finally, NHEC is developing plans for implementing Phase I of an automatic meter reading (AMR) project starting in 2004. The inherent functionality of this AMR system will allow it to

[11] The Load Management Computer utilizes a Windows 95 operating platform. It is a stand alone system as the new servers running the NHEC network do not recognize this operating system.

communicate with NHEC's existing Scientific Atlanta (SA) load control devices after a minor retrofit. NHEC is currently reviewing potential uses of the Load Management System (LMS) and will retrofit SA load control devices as is justified by proposed LMS programs.

E. Current Load Management Program Delivery Flow

As noted earlier in this report, NHEC is no longer actively marketing its load management programs. Instead, new services are provided only upon customer request. The majority, and limited amount of the Co-op's current load management activity relates to existing program infrastructure and equipment maintenance (summarized above), regular load interruptions (based on pre-determined set points), and routine verification testing. The Co-op's current multi-year, partial requirements contract has reduced the economic justification for load interruptions. However, NHEC's existing infrastructure continues to be tapped, and load interruptions continue to be performed to:

(1) Help Co-op members to use their energy more wisely and reduce their electric bills;

(2) Continue to support expectations of members who have heating system operations and usage patterns designed around regular operation of load management by NHEC;

(3) Minimize monthly wholesale delivery service charges at the PSNH delivery points (still linked to a 70% ratchet – non-coincident peak, ½ hour kVA), also resulting in lower costs to Co-op members;

(4) Address occasional local distribution system issues; and

(5) Assist the ISO during tight supply/system peak situations (which provides benefits to the Co-op's partial requirements provider).

In addition, continued implementation of current load interruption protocols improves NHEC's load shape, allowing shifting of some wholesale energy purchases from higher to lower energy cost pricing periods providing the opportunity for lower current costs. This benefit is far reduced compared with prior years when wholesale contract terms contained high and ratcheted demand charges but could prove useful in future power supplier contract negotiations.[12]

When interruptions are made, the Co-op's load management system switches devices off or on based on real-time load at the substation level, and on pre-determined set points and protocols for specific controlled devices. A brief listing of the interruption protocols for key types of controlled equipment is presented below:

[12] Per telecon with NHEC staff.

- Electric Thermal Storage: Controls are normally activated (load interrupted) between 0800 to 1100 and 1700 to 2000.
- Dual Fuel Installations: Limited to 90 minutes/day and 600 hours/month. No seasonal limit.
- Standard Domestic Hot Water (DHW) : Same as dual fuel.
- DHW Storage Units: Same as dual fuel.
- The Co-op also has Special Contracts with a number of larger load interruption-capable (ski area) customers who can be called, 24 hours/day, to interrupt load. In these cases, telephone calls and faxes are used to request interruptions (not the load management system).

F. Recommendations for Future NHEC Load Management Program Activities

NHEC currently has a significant, and generally functional load management control infrastructure. Key to determining the future design, operation and value of load management programs is how the wholesale markets may value and optimize different types of demand response. Thus far, the demand response capabilities offered by small end-users without interval metering, either individually or as part of aggregated programs such as NHEC's, have received less attention than demand response available from large, interval-metered end-users. But presumably some valuation and structures for utilizing the demand response that small end-users can offer will evolve.

Important policy matters and decisions will need to be considered such as:

- Who should be required, or have the opportunity, to aggregate these capabilities and translate them into value for the end-user providers (should it be the load serving wires companies, retail energy suppliers, or competitive marketers?); and
- How can a load serving entity's service territory or wires-based system already in place be utilized in terms of cost and benefit sharing?
- In addition, under NHEC's current wholesale energy supply contract, it has become more difficult to fully recognize and quantify the benefits associated with load management controls.

Based on the research conducted and results described in this report, including our review of the Co-op's existing load management capabilities, we conclude that continuing to maintain and tap NHEC's existing capabilities, expanding and replacing them with similar, but updated

technologies (when appropriate needs and opportunities arise), and moving ahead with more formal research, design and implementation of an expanded load management program based on broader installation and utilization of AMR technology will:

(1) Help to keep energy costs down for participating members and will increase levels of awareness regarding the benefits associated with effective energy management and load control (*i.e.*, maintains and expands the value of embedded load management control investments as a useful energy efficiency educational tool for the Co-op's existing and future member base);

(2) Help to keep wholesale delivery service charges lower on all NHEC member's electric bills by minimizing monthly peak kVA levels seen at the wholesale delivery points;

(3) Support local distribution system reliability and delay potential costly system upgrade requirements;

(4) Provide load interruption capability to support the ISO in managing system-wide and regional system emergency situations;

(5) Improve NHEC's load shape that could prove useful in pricing of its future wholesale power supply contracts;

(6) Create potential opportunities for NHEC (as a NEPOOL member and load aggregator) to participate in existing and future ISO New England demand-response programs that could result in direct revenues to be passed on to participating members through lower rates or other credits;

(7) Leverage existing resources and create opportunities for potential management of statewide load control programs through NHEC's existing extensive radio control area coverage; and

(8) Provide an AMR control platform within already over 1,300 existing customer homes, for use as a formal testing ground for: improving reliability of NHEC's load management control capabilities; reducing meter reading costs and billing errors; providing additional end-use and member specific energy and capacity usage information; and serving as a launching point from which additional products and services could be promoted (convenience controls – lights, heat, hot water; home monitoring; security, etc.) to interested members.

A critical element of these continued efforts will be the careful analysis of each of the 8 items identified above so that strengths and weaknesses can be identified and benefits and costs can be more clearly quantified. Results from such quantification efforts will help to ensure that benefits

associated with limited NHEC load management program funding will be maximized. Therefore, during the remainder of this year and through the first quarter of 2004, the following activities and strategies are recommended:

- Maximize NHEC's existing load interruption capabilities through continued deliberate testing, repair and upgrading of key end-use, controls and switching, and appropriate central load management control devices as necessary;

- Support existing radio tower infrastructure through continued maintenance and installation of necessary equipment for improved communications between end-use devices and load management control center;

- Expand installation of AMR metering in existing member locations, upon equipment failure or member-specific request; and

- Quantify the benefits and costs associated with specific load management opportunities (*i.e.*, lowering participating member's energy bills, supporting local distribution system reliability and delaying potential costly system upgrades; minimizing monthly peak KvA levels seen at NHEC's wholesale power delivery points; and providing load interruption capability to support ISO in managing system-wide peaks and regional system emergency situations); leading to the strategic expansion of NHEC's load management and AMR activities to maximize member and system reliability benefits.

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