executive summary

1

1.1 INTRODUCTION

This document presents the results of a "baseline" evaluation for the New Hampshire Commercial and Industrial New Construction Program known as "nhsaves @ Work/New Construction" and was sponsored by the New Hampshire Monitoring and Evaluation Team (M&E Team). The M&E Team is comprised of representatives of the five New Hampshire utilities: Public Service Company of New Hampshire (PSNH), Granite State Electric Co (GSE), Unitil Energy Systems, Inc., New Hampshire Electric Cooperative Inc (NHEC), and Connecticut Valley Electric Company, Inc. (CVEC)

This evaluation had four primary components. First, a thorough assessment of the program's existing measure savings algorithms was conducted. As a part of the assessment the sources for the algorithms were investigated for their accuracy and suitability with respect to the existing baseline parameters. The second component of the study was to review the recent New Hampshire Energy Code introduced in September of 2002 to assess the potential implications of this document on the baseline algorithms. The third area of focus of this evaluation was to assess the current practices employed for new construction projects in New Hampshire. Finally, based on these three components of the study, recommendations were developed for revisions to the baseline parameters and calculations that define the minimum qualifying levels of energy efficiency improvements and the corresponding energy savings.

This section (Executive Summary) provides a brief overview of the steps followed for the evaluation process and the resulting findings.

Section 2 presents a review of the existing baseline parameters and algorithms for each Prescriptive and Custom measure (and/or measure category) for the New Construction Program as well as a discussion of the origins of these parameters.

Section 3 provides a review of all sections and details of the recent New Hampshire Commercial Energy Code. This section provides a comprehensive comparison of the baseline parameters for the new construction program with the IECC (International Energy Conservation Code) and ASHRAE 90.1 (1999) referenced by the new code.

Section 4 details the findings from primary research based on limited interviews of New Hampshire architects and engineers to assess the current practices incorporated in the New

Construction industry and presents a comparison of current practices with the program baseline.

Section 5 details the findings from secondary research based on literature review on current practices incorporated in the New Construction industry in New Hampshire and nationwide.

Section 6 summarizes the overall recommendations put forth as a result of synthesizing all of the information established in the previous sections associated with the commercial energy code review, baseline parameters comparisons and current practice research.

1.2 OVERVIEW OF THE PROJECT PROCESS

The evaluation process involved four major tasks. Each of these tasks is described below.

Task 1 – Review of current program baseline parameters: This task involved reviewing the current program's baseline parameters and algorithms for each approved Prescriptive and Custom measure. Additionally, an assessment of the projects conducted under the New Construction Program to date was conducted.

Task 2 – Review of new commercial energy code: This task included a comprehensive review of the new commercial energy code, its relationship to the New Construction Program and associated baseline parameters. The energy codes were reviewed from the perspective of the New Construction Program to determine how the new code relates to the current approved measures. Similar to other states in the region, the recent New Hampshire energy code adopted in 2002 is based on ASHRAE 90.1-1999 and the International Energy Conservation Code (IECC) 2000. The code addresses numerous technical areas applicable to new construction or major renovation of commercial buildings such building envelope, mechanical systems and lighting systems.

Task 3 – Review of existing information on current practice: This task targeted a comprehensive compilation and review of data describing the current new construction practices in New Hampshire's commercial sector and the relationship to the Utilities' New Construction Programs baseline parameters. While the new energy code represents one area of consideration for the baseline practices, the actual "typical" practice in New Hampshire is another major consideration. The objective of this task was to gather and organize information to determine what the current practices are and to establish associated recommendations for enhancing the New Construction Program baseline assumptions. For this task, **ERS** evaluated existing program history, reviewed pertinent literature sources and conducted a limited number of direct outreach sessions with market actors (architects, engineers, contractors, distributors) involved in new construction in New Hampshire.

Task 4 – Synthesis of Information and Development of Recommendations: Upon completion of Tasks 1 through 3 described above, the information obtained was reviewed collectively in relation to one another to provide interrelated insights. The result of this

effort was to establish appropriate recommendations for revising designated baseline elements of the New Construction Program that integrates all elements of the evaluation.

1.3 REVIEW OF PRESCRIPTIVE MEASURE BASELINE ALGORITHM

The Prescriptive program offers rebates for lighting, motors, HVAC systems, chillers, and variable frequency drives, and dry transformers that meet designated requirements. The projects implementing Prescriptive measures have pre-defined baseline parameters and savings calculations set forth by the program.

There are numerous parameters and specific calculations associated with each of the measure categories under the Prescriptive track of the program. Our observations for each type of technology are discussed briefly in the following paragraphs. The algorithm review for each measure is presented in greater depth in Section 2 of this report.

Lighting

The savings algorithms associated with the Prescriptive measures for lighting systems have been determined by various studies that are ongoing since 1994. The analysis was developed code by code (the program incorporates lighting codes to identify technology groupings) and looked at proposed baseline technologies and their relationship to the demand and energy savings calculation algorithms. The baseline algorithms for many of the lighting technologies were acceptable, however, in numerous cases we have recommended specific changes.

Unitary Systems

The base efficiencies for unitary equipment are based on a study conducted by Northeast Utilities in association with Northeast Energy Efficiency Partnerships (NEEP) in 2002. The savings algorithms for unitary systems up to 30 tons were reviewed. Based on our investigation of the study conducted by NEEP, we believe that the energy performance values used in the baseline algorithm are acceptable. We feel that further refinement of the equivalent full load hours for New Hampshire would be beneficial, but would require further study investigation.

Chillers

The program considers air-cooled chillers up to 150 tons and water-cooled chillers up to 1,000 tons. The existing energy efficiency rating (EER) values for air-cooled chillers are the average efficiencies of the current available equipment based on internal survey, code review and project experience. In addition to internal surveys and ASHRAE standards, a field survey conducted by HEC in 2000 was also considered for efficiency values of water-cooled chillers. Based on the baseline algorithm, we believe that the values used are consistent with the current technological developments and hence are acceptable.

Motors

The program covers motors from 1 to 200 HP. The baseline motor efficiencies are taken from the National Electrical Manufacturers Association (NEMA) standard efficiencies. The

base efficiencies are NEMA standard efficiencies. The savings algorithms are correct and reflect the design when the motor runs at nominal full load, thus estimating the gross demand and energy savings. This algorithm may be applicable as it is assuming that the individual utility company incorporates a load factor when net energy savings are calculated. For example, Granite State Electric (GSE) applies a loading factor of 62% to estimate the net demand and energy savings for their programs. In the case where a utility is not incorporating a factor for their net savings, the energy savings algorithms should reflect the operating load. In absence of specific load data (such as that used by GSE) we suggest that an "average load factor" of 75% be incorporated for the energy savings calculation (based on "Energy Efficient Motor Systems: A Handbook on Technology, Program, and Policy Opportunity", by Nadel, Steven, and other, ACEEE, Washington D.C., 2002).

Variable Frequency Drives

The program offers rebates for VFDs installed in HVAC applications with rated capacities up to 20 HP. Based on our discussions with Mr. Keena, of National Grid, who has been involved in the program development and was interviewed to obtain information on the origins of the program parameters, the demand savings algorithms associated with the Prescriptive measures for variable frequency drives (VFD) have been determined by a study developed in 1994-1996. We believe that the study on which the algorithms are based is still applicable and that no changes are required at this time.

1.4 FINDINGS APPLICABLE TO ENERGY CODES AND THE NEW CONSTRUCTION PROGRAM

This section presents the findings of a comprehensive review of the recent New Hampshire Commercial Energy Code and it's relationship to the nhsaves @ Work/New Construction Program baseline parameters. In the Spring of 2002 New Hampshire agreed to adopt the IECC 2000 (International Energy Conservation Code), and subsequently became a mandatory requirement in the Fall of 2002.

The new energy code was reviewed from the perspective of the New Construction Program with the intention of determining how the new code relates to the existing Prescriptive and Custom measures. In addition to IECC 2000, we reviewed ASHRAE Standard 90.1-1999, which is referenced in Chapter 7 of the IECC 2000 document. It is also valuable to understand that the New Construction Program may have broader technology scope than the energy code, particularly when Custom measures are considered.

It should be noted that the IECC 2000 Code Chapter 8 prevails in the majority of instances for New Construction projects, and that ASHRAE Standard 90.1-1999 only comes into play when designated criterion specified in IECC 2000 are not satisfied. Although it is difficult to predict definitively, it appears that most new construction projects will fall under the IECC specifications. Subsequently, the baseline algorithm parameters need to reflect the IECC 2000 requirements as a rule, and not ASHRAE Standard 90.1. The nhsaves baseline parameters, as a whole, do exceed the requirements put forth by the IECC 2000 Code.

The tasks involved in the review process were Code Review and Outline, Comparison with Existing Baseline Parameters, and Development of Code-Based Baseline Parameters & Observations.

1.4.1 PRESCRIPTIVE MEASURES

The following paragraphs discuss our observations from code review and comparisons for Prescriptive measures.

Lighting

The nhsaves New Construction Program does not directly consider lighting power densities (LPD), but instead requires specified lighting fixture types and efficiencies. In contrast, the energy code focuses on LPD, with each space or building type being assigned a maximum allowable lighting power density. The intention of the nhsaves program is that if specification of efficient technologies (T8 lamps, electronic ballasts, metal halide fixtures, efficient fixture configurations, etc.) is utilized in typical uniform layouts, code mandated LPD levels will be met. However, we believe that it is important to consider the integration of LPD calculations into the nhsaves New Construction Program. Reference Section 6 for further discussion associated with LPD.

Unitary Systems

In a new construction project for unitary systems, the efficiency specified by the Utility to qualify for rebates is considered as the baseline and is compared with the efficiency specified by the energy codes. Our review for the HVAC unitary equipment indicates that the efficiency values required for rebates under the program are greater than the efficiencies specified by the IECC 2000 energy code.

Chillers

Similar to the unitary systems, the baseline minimum efficiency requirement specified by the Utility for rebate eligibility was considered for comparison to the new energy code. The code comparison indicated that the minimum efficiency required to obtain rebates for air-cooled chillers with capacities less than 150 tons and water cooled chillers with capacities between 30 and 1,000 tons, is greater than the efficiencies specified by IECC 2000 energy code.

Motors

The IECC 2000 does not have a section that addresses minimum energy efficiency for motors. However, the NEMA premium qualifying efficiencies for the MotorUp program was observed to be higher than the minimum efficiencies imposed by ASHRAE Standard 90.1-1999.

Variable Frequency Drives

The codes, as a whole, require the use of VFDs in the supply and return fan applications for motors above 25 HP. VFDs on exhaust fans are not adequately referenced in the codes.

The codes indirectly indicate the requirement to install VFDs on certain hydronic applications.

Dry Type Transformers
Neither IECC 2000 nor ASHRAE Standard 90.1-1999 address Dry Type Transformers.

1.4.2 CUSTOM MEASURES

The **Custom Program** is specifically intended for applications that are not covered by the Prescriptive programs. Similar to the Prescriptive programs, the Custom programs have qualifying criterion and, in some technologies, specified requirements that must be met by the project.

The observations from our code review and baseline parameter comparison for the Custom measures are as followed:

Windows & Skylight Glazing
For window and skylight glazing, a part of the building envelope, the Custom program specifies criterion in a different manner than the energy code. The nhsaves @ Work Program focuses on shading coefficients based on the percentage of wall that is glazed. The New Hampshire energy code, however, considers solar heat gain coefficient (SHGC) instead, and does not address shading coefficient (SC). In addition, the code specifies criterion for building envelope based on insulation, fenestration (all areas of building that let in light), and air-leakage. The two approaches simply represent different methods of specification and no major conclusion is to be drawn.

Lighting
For lighting, the IECC 2000 and ASHRAE Standard 90.1 1999, in contrast to the baseline parameters, do not specify particular types of lighting fixtures for interior lighting but instead specify an allowable lighting power density (refer to Section 6 for further discussion of LPD). The nhsaves @ Work Custom program has a somewhat broad specification for interior lighting controls independent of application, while the energy code specifies designated controls for designated applications. For exterior lighting, the energy code and program standard practice used different approaches to achieve the same result. The code incorporates efficacy while the nhsaves Custom program defines fixture technology. Both approaches effectively achieve a similar result for exterior applications.

Mechanical Systems
Based on our comparative review of the various components of the Custom mechanical system descriptions with ASHRAE Standard 90.1-1999 and IECC 2000, our observations are presented below:

Criteria specified for mechanical systems associated with office buildings, fume hoods, and kitchen hood exhaust systems are fully specified in the baseline practices, but are not addressed as completely in the codes. Additionally, for manufacturing and office areas

specified in the baseline practices, the descriptions are not specific enough to suggest inconsistency with the codes.

Unitary HVAC Systems
Baseline efficiencies of *unitary* HVAC systems are appropriate relative to the code specified efficiencies. It should be noted that the codes do not directly address water source heat pump mechanical system aspects.

Chillers
Baseline efficiencies of packaged reciprocating *chillers* were observed to be higher than the efficiencies specified by the code for both air-cooled and water-cooled chillers. However, the baseline practice state certain requirements like cooling tower selection, chiller sequencer controls, heat exchangers for free cooling, etc. that are not addressed by the codes.

Building Control Systems
The baseline practice requirements for building control systems were found to comply with the New Hampshire energy codes.

Boilers
The baseline requirements for boilers are not addressed by the codes.

Other Applications
The new energy code does not address many other Custom program applications such as refrigeration, waste water treatment, ice rinks, process related equipment, plastic injection molding machines, and air compressors.

1.5 INFORMATION RELATED TO CURRENT PRACTICES AND THE NEW CONSTRUCTION PROGRAM

As part of the overall evaluation study process, **ERS** conducted a series of on-site interviews of market actors in the design and construction trades in New Hampshire. Six (6) interview sessions were done through this limited research effort, each representing comprehensive discussions with groups of architects, engineers, distributors, and contractors. Each of the interview sessions took place at the participant firm's office, with the objective of supporting the firm's participation and encouraging multiple individuals at the session. In all, we interviewed approximately 45 individuals through the process.

Each Current Practice session required between 30 and 60 minutes to complete the survey component. Following the interview, **ERS** immediately conducted an energy code technical assistance session, which lasted between 90 minutes and 3 hours. While the energy code session was really intended to be an incentive for the participating firm, discussions held during this phase of the meeting provided additional data that confirmed or enhanced our findings from the interview.

In conducting the interview, we used an informal process where we used an outline questionnaire to guide us through a series of focus areas and points of inquiry. The

interviews began with a series of demographic questions that addressed the type of firm, the nature of their practice, the geographic region they work in, and the types of facilities for which they design and install their systems. We then discussed a variety of different technology areas, requesting information on the types of systems the firm designs or specifies, and the efficiency of those systems. Appendix E provides a sample copy of the questionnaire used during interview process.

Our findings from the series of interviews indicate that there have been a number of impediments to the adoption of high performance energy efficient systems in the New Hampshire market. The new programs deployed in the state in the past year have already made significant steps towards moving the state towards more efficient practices. Market factors emphasizing first cost concerns have remained a barrier however to the penetration of new premium efficiency technologies. These findings are completely discussed in Section 4 of this report.

1.6 RECOMMENDATIONS AND CONCLUSIONS

Tables 1-1 through 1-3 present a concise overview of our findings from the study for lighting systems, chiller systems and unitary systems.

As discussed above, for motor systems we recommend adding a 75% load factor in the baseline algorithm if the utility does not calculate net savings using a specific motor load factor. However, additional study would be required to accurately estimate the loading factor.

No changes have been recommended for variable speed drives since the factors used in the algorithm are based on prior studies and appear to be reasonable. Refinement of these factors used in the algorithms may be of some benefit but would require additional study.

Table 1-1
Recommended Changes To Prescriptive Measures for Lighting Applications

Measure Description	Comments	Measure Code	Recommended Changes
High Efficiency Fluorescent Lamps and Ballasts	Rebate limited to under 300 kW Customers.	**10**	Change the customer demand limit from 300 kW to 100 kW.
High Efficiency Recessed Fluorescent Fixtures	Existing code sets same savings ratio factor for both 83% efficient prismatic lensed fixtures and 75% efficient parbolic lensed fixtures.	**30**	No changes are recommended to the algorithm.
Low Glare Recessed Fluorescent Fixtures	Existing base case fixture lamps are not clearly defined and are no more significantly represented in the market.	**32**	Phase-out of the Code 32 measure
Low Glare Indirect Fluorescent Fixtures	Existing base case and proposed case fixture requirements are complicated.	**33**	No changes are recommended to the algorithm. Changes to the measure description are described in Section 6.
Fluorescent Fixtures with High Efficiency Reflectors - 4'	Rarely used in new construction. More efficient alternatives available.	**41**	Phase-out of the Code 41 measure
Fluorescent Fixtures with High Efficiency Reflectors - 8'	Rarely used in new construction. More efficient alternatives available.	**42**	Phase-out of the Code 42 measure
1 lamp Compact Fl. HardWired Fixture	Existing analysis based on the replacement of incandescent lamps with CFL lamps based on matching the initial lumens of the two technology types.	**21**	Reduce the savings ratio from the current 3.7 to 3.0
2 lamp Compact Fl. HardWired Fixture		**22**	
Compact Fluorescent Fixtures with dimming ballast		**23**	
LED Exit Sign	Rebate limited to under 300 kW Customers.	**25**	Change the customer demand limit from 300 kW to 100 kW.
High Bay Fluorescent Fixtures <= 219 Watt	Replace MH and HPS HID lamps with HIF lamps	**56**	Reduce the savings ratio from the current 1.35 to 1.2
High Bay Fluorescent Fixtures > 219 Watt	Replace MH and HPS HID lamps with HIF lamps	**57**	Reduce the savings ratio from the current 1.35 to 1.2
Remote-Mounted Occupancy Sensor	Existing control energy savings algorithm is too aggressive and does not take into account the diversity of lighting control technologies.	**61**	No change suggested (exception Code 61 & 64). For Codes 61 & 64 we recommend the Utilities continue supporting occupancy sensors as occupancy sensors save more energy than multi-level switching. We suggest more studies be conducted to accurately characterize different lighting control types and associated savings.
Daylight Dimming System		**62**	
Occupancy Controlled High Low		**63**	
Wall Switch type Occupancy Sensor		**64**	
HID Fixture High-Low Controls		**66**	
HID Fixture Dimming Systems		**67**	

Table 1-2
Recommended Changes to Prescriptive Measures for Chiller Applications

Measure Description	Existing Baseline	Recommended Changes
Air Cooled Chillers <= 150 tons	9.8 EER	No changes recommended to the algorithm parameters. Refinements to the effective full-load hour (EFLH) values for the savings calculations may be justified but further study is required in order to accurately develop this parameter.
Water Cooled Chillers 30 to 70 tons	0.85 kW/ton	
Water Cooled Chillers 71 to 150 tons (screw or reciprocating)	0.813 kW/ton	
Water Cooled Chillers 71 to 150 tons (centrifugal)	0.651 kW/ton	
Water Cooled Chillers 151 to 300 tons	0.69 kW/ton peak	
Water Cooled Chillers 151 to 300 tons (IPLV)	0.67 kW/ton IPLV	
Water Cooled Chillers 301 to 1000 tons	0.62 kW/ton peak	
Water Cooled Chillers 301 to 1000 tons (IPLV)	0.57 kW/ton IPLV	

Table 1-3
Recommended Changes to Prescriptive Measures for Unitary Applications

Measure Description	Existing Baseline Efficiencies (EER/SEER)	Recommended Changes
Unitary AC and Split systems <65,000 btuh (Tier 1)	**10.0**	No changes recommended to the algorithm parameters. Refinements to the effective fulload hour (EFLH) values for the savings calculations may be justified but further study is required in order to accurately refine this parameter.
(Tier 2)	**10.0**	
Unitary AC and Split systems >65,000 btuh to 135,000 btuh (Tier 1)	**8.92**	
(Tier 2)	**8.92**	
Unitary AC and Split systems >135,000 btuh to 375,000 btuh (Tier 1)	**8.6**	
(Tier 2)	**8.6**	
Air to Air Heat Pumps < 65,000 btuh (Tier 1)	**10.0**	
Air to Air Heat Pumps > 65,000 btuh to 135,000 btuh (Tier 1)	**10.0**	
(Tier 2)	**10.0**	
Air to Air Heat Pumps > 135,000 btuh to 375,000 btuh (Tier 1)	**8.6**	
(Tier 2)	**8.6**	
Water Source Heat Pumps < 375,000 btuh (Tier 1)	**11.5**	
(Tier 2)	**11.5**	