Evaluation of
Cape Light Compact
Residential New Construction
Green Building
2003 Demonstration Project

Prepared for
the Cape Light Compact

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I. Executive Summary

The 2003 Cape Light Compact's Residential New Construction Green Building Demonstration Project was originated to maximize cost-effective energy savings and other non energy green benefits in four pilot homes. The project also set out to identify market barriers that inhibit the development of green or high-performance homes to inform its actions going forward. The evaluation team was asked to compare the Demonstration Project with the existing ENERGY STAR Homes program and to identify costs and benefits of the program in comparison to ENERGY STAR. The pilot involved the construction of four homes built to the Vermont Builds Greener (VBG) residential green building standard. The evaluation team visited each of the four houses, interviewed the homeowners and builders, and conducted a performance evaluation of each house to determine if they were performing as originally modeled.

Overall Findings:

- All participants are very happy with their homes in terms of size, functionality, aesthetics, maintenance, energy costs and comfort, and recommend the use of a green building standard on Cape Cod.
- The VBG checklist was found to be a very useful/helpful tool which needs to be supplemented with additional information resources.
- The energy benefits were found to be cost-effective, i.e. the incremental costs were more than offset by the associated savings. However the energy savings were not the primary customer motivation for building to a green standard.

Other areas covered in this report include:

- What were the challenges to building green?
- The need for green building professional training;
- Access to green building materials;
- Subcontractors and suppliers gaps in knowledge of green building methods and materials; and
- Non energy benefits.

Recommendations:

- Continue to collaborate with and support the work of programs with similar goals such as ENERGY STAR Homes;

- Leverage other resources that support green homebuilding objectives such as Federal tax credits, Massachusetts Technology Collaboartive (MTC) incentive programs, the Green Homes Northeast (GHNE) effort and others;
- Utilize past participants as information resources;
- Quantify and track non-energy benefits; and
- Use the U.S. Green Building Council's (USGBC) LEED for Homes green building standard going forward.

II. Introduction

The practice of green home building utilizes methods and materials that are environmentally responsible and creates a building that is healthy to occupy, cost effective to build, own and operate and durable. This practice has been around for centuries, but has had a resurgence in the last few decades in response to the increased number of buildings constructed that were unhealthy, expensive to operate and were not lasting as long as they should. In response to an increasing problem of "green washing," or invalid claims of green, standards were developed, along with third party verification to ensure that claims of green are well founded. In the residential sector several rating systems have emerged. For this pilot, the Cape Light Compact selected the Vermont Built Green standard as this was widely accepted as the most aggressive of the many U.S. sustainable residential building standards. Since that time, the LEED for Homes program has been developed by the USGBC with input from local and national stakeholder groups. As with all residential green building programs, it is a voluntary initiative promoting the transformation of the mainstream home building industry towards more sustainable practices. Like VBG, LEED for Homes helps define green buildings by establishing a common standard of measurement, promoting integrated, whole-building design practices and materials, stimulating green competition, raising consumer awareness of green building benefits, and working toward transforming the building market to more sustainable practices.

III. Methodology

The evaluation team and the Cape Light Compact agreed to the following methodology for the evaluation:

1. Interview all homeowners and builders who participated in the demo to determine the amount of effort and/or specific dollar amount that was required to achieve the score on the Vermont Builds Greener (VBG) scorecard. (Additionally two perspective green home builders on the Cape were interviewed as well as two building suppliers and all staff who worked on the project: CLC, Honeywell, CSG, VEIC, NEEP.)

2. Conduct a performance assessment using blower door and other performance evaluation equipment to determine if the houses are performing as modeled.
3. Update the REM energy use assessment software files for the four homes with the post occupancy performance data
4. Create a user defined reference home in REM taking a Cape Cod specific set of information from the 234 ENERGY STAR homes built on the Cape during the same time period to establish a baseline for comparison.
5. Create a user defined reference home in REM taking a Cape Cod specific set of information from the Massachusetts new construction baseline study of homes built on the Cape during the same time period to establish a standard practice baseline for comparison.
6. Collect, evaluate and analyze cost and savings data provided to the team from the homeowners and builders of the four demonstration homes and perform a life cycle cost assessment.
7. Evaluate the input on the scorecards and suggest a revised scorecard for use in an ongoing program

IV. Interview results

The interviews were central to the evaluation. All four homeowners and home builders were interviewed as well as two potential new green homeowners, and two building suppliers. The participants were all extremely cooperative and had a lot to say about their experiences in the program and/or with green building in general. In order to most directly convey these experiences, we are providing you with a list of direct quotes from program participants. We have organized them into several numbered topics:

1. Universally the participants found the **checklist** useful:

The VBG checklist was created over the span of six years by independent regional experts; builders, architects, and energy consultants. Since the development team was comprised of volunteers without any sponsorship or affiliation, the VBG program presents straight-forward answers to questions about sustainable building that are specific to Vermont and untainted by green washing or specific product sponsorship. The resulting VBG checklist is widely considered to be the greenest residential green building standard in the country. The approaches have been customized for use in Vermont and are supported by local experts in construction, energy efficiency, and environmental sustainability. All builders and homeowners found that the checklist helped them understand the design elements and choices inherent in a green home as

well as evaluate how environmentally considerate their home really is. Comments from the interviewees include the following:

- "It helped to make me think about things that I might not have thought about."
- "The VBG checklist gave us ideas about where to focus our efforts."
- "Having to meet the requirements makes us more diligent to ensure that what we'd like to have happen actually does happen."
- "The scorecard gives us a benchmark, so we are not making arbitrary decisions about what is really important."
- "Because of the scorecard, we can understand where we should not negotiate on Green."
- "VBG is also a motivational tool! We are considering more than what we thought about originally. For example, a friend is redoing her kitchen and her 'old' cabinets are just fine, so I told her the story of VBG and the scorecard and asked what she was doing with her old cabinets. She is considering letting us use them in the house!"
- "My top suggestion is finding ways of using the VBG scorecard more proactively: Having a scorecard means that the specific things to do are in black and white. This is very helpful. The scorecard also implies that it is both possible and better to do things as listed in the scorecard. This makes it objective – it is not just one wacky environmentalist's idea. The organization, validation of practices and objectivity of VBG makes it a great tool for educating and motivating. No one can legitimately say 'that doesn't work' if it's on the scorecard! And with people backing up the scorecard who can explain HOW to do the things listed, the loop is closed."
- "We both learned from this project and without the drive from the program and checklist we likely would not have gone as far as we did"

2. There was difficulty locating **green products** locally**:**

Several participants expressed difficulty finding products locally that complied with certain approaches on the checklist. An interview with a local hardware and lumber supplier indicates that his customer's top priority is quality and there is not evidence of a demand for environmentally-friendly products adequate to change his supply at this point. The lumber supplier interviewed had developed a relationship with a mill over time and is assured a certain level of quality (i.e. straight dimensional lumber). Unless their current mill was to begin offering FSC-certified lumber, they would be forced to establish a relationship with a new mill and risk losing the quality they were assured from their previous mill, The lumber supplier did suggest that if he could get sustainably harvested lumber with the same quality assurance, he would sign

on because he understood the benefits of a well-managed forest. He further expressed that it is simply not practicable for him to offer both green certified lumber and non-certified lumber.

At the same time a long standing hardware and lumber supply outfit in Provincetown will be changing hands and the new owner has expressed an intention to highlight environmentally friendly products. He plans to call his business the Northeast Green Building Supply Center and serve not only the tip of the Cape but also sell and deliver products throughout New England by truck, mail, and E-commerce. There is a growing demand, and concurrent education among other building material suppliers on the Cape regarding green products. As a result of these developments, and the potential for an ongoing CLC green building program, we perceive the barrier of access to green materials to be a temporary one.

Some of the comments from the interviewees on green products included the following:

- "Having green materials showcased locally would help."
- "My customers are demanding quality, not environmentally friendly products"
- "Inventory space is too limited to carry two types of products"

3. Clearly and repeatedly there was a need expressed for additional **information resources.** This need goes all the way from a preliminary plan review prior to the commencement of construction, to phone support throughout construction, to on site inspection. As the quotes point out, participants feel that one of the highest and best uses of program funding going forward would be to provide an accessible and responsive information resource. One participant suggested using the past participants as resources to future perspective green homeowners and builders. This approach could be a critical resource for future program success. This could be in the form of case studies, home tours, volunteer time to answer questions, or all of the above.

Some of the quotes related to information resources included the following:

- "If I could have accessed more information, I would have been able to do a lot more."
- "I would have liked to talk to a person for really specific questions."
- "There is nothing better than sitting down with a real person after going through the checklist. A face to face, where questions are answered and approaches are validated, is key. I would even volunteer to help others after we get certified!"
- "This is only as good as the person who is the expert, but if volunteer experts can be trained, it would do a lot for educating less knowledgeable and skeptical homeowners and builders."

- "I would gladly have traded the incentives for more technical support. For example, I would have liked someone from the Cape Light to come to the site and assist me in explaining to a building inspector why I don't need to vent a particular sloped attic. I felt like I was on my own."

In summary, participants foresaw a need to provide a plan review early on to identify problems and/or ways of enhancing the proposed design for sustainability. There was a suggestion to make sure air sealing and insulation are included in original construction documents to ensure their inclusion in the base contract and avoid change order extras. One of the VBG requirements is to provide the new homeowner with a user's manual describing the systems and appliances in their new home. It was identified as a helpful suggestion that there should be a template for this manual to ensure that all the pertinent information is captured and conveyed to the new owners.

4. Provide builder and subcontractor **training**, and a list of qualified and/or certified sub-contractors (for example BPI (Building Performance Institute) certification).
Homeowners and builders noted a gap in the knowledgebase of many of the subcontractors, builders, architects and suppliers on the Cape. One of the participants was representative of others when he said he felt there was a need to "Develop a community of contractors and builders with the skill and know how to quote, cost, and accomplish. If builders do not have the knowledge, they are unlikely to offer the options nor will they be capable of presenting the costs to owners in such a way as the owner can evaluate the options." For example, it was difficult to locate a cellulose installer, or to get competitive quotes for a renewable energy system or to find local cotton insulation. Participants suggested a comprehensive training effort to bring subcontractors up to speed. A list of certified individuals and organizations would ease the process of implementing green building.

- Based on our conversations, suggested training topics include the following:
    - Understanding green building standards and strategies;
    - Proper design and installation of renewable energy systems;
    - Sizing and appropriate design of HVAC systems;
    - Air sealing techniques;
    - Insulation options and proper installation;
    - Ventilation techniques (How to achieve good IAQ);
    - Waste reduction practices;
    - Advanced framing (Optimal Value Engineering); and
    - Include factory builders in education efforts.

Some of the comments from the Demonstration Project included:

- There are "huge knowledge gaps in the supplier/contractor community regarding building methods/techniques and materials."
- "A network of trained volunteers/staff that can reduce to practice the concept of green would be a way to keep homeowners excited, and keep builders from talking people out of their good intentions."

5. **Incentives** allowed participants to achieve approaches they otherwise would not have committed to, for example renewable energy systems, additional air sealing and insulation, and high performance heating and hot water systems were all installed because of the incentives offered as part of the Demonstration Program.

IV. Costs and Savings:

We found it difficult to obtain accurate and thorough incremental cost and savings data from participants. Participants complained that it is difficult to gather accurate cost and savings data 2 years after project completion. It is recommended that the program provider require tracking and verification of costs and savings for all participants who receive incentives in any future program. This could be accomplished through a hold back on some of the incentive dollars until data is provided. We received excellent incremental cost data from the Habitat homes, but their cost of construction is not a reasonable proxy for average building costs. The other two homes provided partial cost and savings information. However, combining the information from all four homes with our own information regarding construction costs, we determined an average incremental cost of approximately 2% of total construction costs. This incremental cost is primarily for energy efficiency features such as HVAC, water heating, air sealing, insulation, lighting and appliance upgrades. To calculate savings, we used the REM/Rate software and actual post occupancy measurements of air infiltration and lighting and appliances in the four homes. We created two reference homes, one is a composite home created from Cape Cod specific homes in the MA residential new construction baseline study. The other reference home was created using information from the ENERGY STAR Homes program files to build a Cape Cod-specific ENERGY STAR reference home.

The summary in table 1 below details the energy savings of the green homes compared to the MA new construction baseline home.

Savings from Cape Cod Green Homes compared to MA RNC Baseline Homes

						kW and kWh Savings Include Line Loss Savings						
No.	House Size (sqft)	Rating Date	HERS Score (v11.4)	Space Heating Therms Savings	DHW Therms Savings	Cooling Peak kW Savings (w/line loss)	Heating Peak kW Savings (w/line loss)	kWh Heating Savings	kWh - Cooling Savings	REM/ Rate kWh - L&A Savings	Est. kWh from E-Star Lights and Appliances	Total Annual kWh Savings / House
1	1041	03-29-04	94	174.70	143.08		0.06	0.00	0.00	-31.32	962.50	931
2	2405	03/31/04	92	346.38	0.00	1.08	0.09	28.22	592.61	-103.36	962.50	1,480
3	1120	11/21/03	91.1	60.14	49.19		0.14	0.00	0.00	-32.89	962.50	930
4	1120	11/21/03	91.9	136.86	55.21		0.14	0.00	0.00	-32.89	962.50	930
TOTA	5686			718.1	247.5	1.1	0.4	28	593	-200.5	3,850.0	4,270.4
Avera	1,422		92.3	179.5	61.9	0.27	0.10	7	148	-50.11	962.50	1067.60

Notes:
1) Negative entry equals an increase in kWh, postive entry is a reduction in kWh
2) VEIC is evaluating the cooling kWh savings algorthims from REM/Rate compared to the Cool Homes savings algorthims (Proctor). As such, RNC cooling savings methodology may vary in the future.
3) L&A Savings are negative primarily because the UDRH home did not have mechanical ventilation and the rated homes do.
4) All kW and kWh reported savings include savings attributed to reduced line losses.
5) E-star Bulbs: 50 kWh; E-Star Fixtures 75 kWh; E-Star RF 100kWh, E-Star CW 75 kWh, E-Star DW, 40 kWh; Gas Furnace with ECM Motor,
6) Estimate 10 bulbs, 5 fixtures, 50% E-Star CW, 50% E-Star RF, and Gas Furnace with ECM Motor
7) Assumed baseline CAC was 13 SEER, with an actual adjusted SEER rating of 10.0. Assumed Green Home SEER was 13.0 as installed.

Savings estimates compiled by: Toben Galvin/Richard Faesy, VEIC, (802) 658-6060 x1110, tgalvin@veic.org

Table 1

The summary in table 2 below compares the green homes to an ENERGY STAR baseline home:

Savings from Cape Cod Green Homes compared to Avg. Cape Cod ENERGY STAR Home

						kW and kWh Savings Include Line Loss Savings						
No.	House Size (sqft)	Rating Date	HERS Score	Space Heating Therms Savings	DHW Therms Savings	Cooling Peak kW Savings (w/line loss)	Heating Peak kW Savings (w/line loss)	kWh Heating Savings	kWh - Cooling Savings	REM/ Rate kWh - L&A Savings	Est. kWh from E-Star Lights and Appliances	Total Annual kWh Savings / House
1	1041	03-29-04	94	136.92	143.08		0.05	0.00	0.00	62.64	0.00	63
2	2405	03/31/04	92	260.79	0.00	1.26	0.08	24.34	538.74	-93.96	0.00	469
3	1120	11/21/03	91.1	35.54	52.62		0.12	0.00	0.00	61.08	0.00	61
4	1120	11/21/03	91.9	79.29	59.07		0.12	0.00	0.00	61.08	0.00	61
TOT	5,686			512.5	254.8	1.3	0.4	24	539	90.8	0.0	654
Ave	1,422		92.3	128.1	63.7	0.32	0.09	6	135	22.71	0.00	163.48

Notes:
1) Negative entry equals an increase in kWh, postive entry is a reduction in kWh
2) VEIC is evaluating the cooling kWh savings algorthims from REM/Rate compared to the Cool Homes savings algorthims (Proctor). As such, RNC cooling savings methodology may vary in the future.
3) L&A Savings are negative primarily because the UDRH home did not have mechanical ventilation and the rated homes do.
4) All kW and kWh reported savings include savings attributed to reduced line losses.
5) Assume no L&A savings for the Green Homes as the penetration of efficient L&A would be the same as the E-Star Homes
6) Assumed baseline CAC was 13 SEER, with an actual adjusted SEER rating of 10.0. Assumed Green Home SEER was 13.0 as installed.
7) Assume Lighting and Appliance types in the Green Homes vs. the E-Star Homes are the same

Savings estimates compiled by: Toben Galvin/Richard Faesy, VEIC, (802) 658-6060 x1110, tgalvin@veic.org

Table 2

Taking the savings outlined above for an average of the four houses, and the incremental costs as 2% of the average home construction cost ($165/sq ft X 1400 sq ft X 2% = ~ $4,600) and calculating the cash flow impacts to homeowners, yields the following results for the average home compared to 1) the average new Massachusetts home (table 3) and 2) an average Cape Cod ENERGY STAR Home (table 4):

CLC green homes compared to MA res new con baseline			
Cash Flow Forecast	Present Value	**cash flows** YR 1	
Savings	$ 404	$ 416	
Loan payments	$ (360)	-$371	
Net cash flow	$44	$46	
Cummulative cash flow		$46	
Net Presednt Value-NPV	$44		
Benefit to Cost ratio-B/C	1.12		
Inputs:	Loan term years	30	
	Loan rate	7.00%	
	Total Installed Cost	$4,600	
	Incentive Buy Down	$0	
	Incremental cost	$4,600	
	Energy escalation	2.5%	
	Real discount rate	3%	

Table 3

CLC green homes compared to Cape Cod ENERGY STAR home baselir			
Cash Flow Forecast	Present Value	**cash flows** YR 1	
Savings	$ 235	$ 242	
Loan payments	$ (454)	-$467	
Net cash flow	-$219	-$226	
Cummulative cash flow		-$226	
Net Present Value-NPV	-$219		
Benefit to Cost ratio-B/C	0.52		
Inputs:	Loan term years	30	
	Loan rate	7.00%	
	Total Installed Cost	$5,800	
	Incentive Buy Down	$0	
	Incremental cost	$5,800	
	Energy escalation	2.5%	
	Real discount rate	3%	

Table 4

Year one cash flows in table 3 show the investments in energy savings pay for themselves when compared to the typical new home being built on the Cape (savings in year one are greater than the loan payment for the upgrades, $416-$371.) However, when the average of the four homes is compared to the average ENERGY STAR home in table 4, the analysis shows that the incremental costs to go above ENERGY STAR are not offset by the energy savings.

When we add in the cost of the solar water heating system installed on one of the four homes it pushes the incremental cost of the average home to $5,800. (Cost of solar system ~ $4,800. We used ¼ of this cost and ¼ of the associated savings in the average home.) In this scenario outlined in table 5 below, when compared to the Massachusetts baseline home, there is a negative cash flow in years 1-5, then the cash flows go positive, cumulative cash flow goes positive in year 11, and ultimately lead to a positive net present value and a benefit cost ratio > 1. Performing this calculation for the green home with solar water heating compared to the ENERGY STAR baseline (not shown), the net present value is negative and benefit to cost ratio is < 1.

CLC green homes compared to MA res new con baseline													
Cash Flow Forecast		**cash flows**	Year										
	Present Value	YR 1	2	3	4	5	6	7	8	9	10	11	
Savings	$ 7,723	$ 416	$ 427	$ 437	$ 448	$ 460	$ 471	$ 483	$ 495	$ 507	$ 520	$ 533	
Loan payments	$ (6,954)	-$467	-$467	-$467	-$467	-$467	-$467	-$467	-$467	-$467	-$467	-$467	
Net cash flow	$769	-$51	-$41	-$30	-$19	-$8	$4	$15	$28	$40	$53	$66	
Cummulative cash flow		-$51	-$92	-$122	-$140	-$148	-$145	-$129	-$101	-$62	-$9	$57	
NPV	$769												
benefit to cost ratio	1.11												
Inputs:	Loan term years	30											
	Loan rate	7.00%											
	Total Installed Cost	$5,800											
	Incentive Buy Down	$0											
	Incremental cost	$5,800											
	Energy escalation	2.5%											
	Real discount rate	3%											

Table 5

Below are the results of running the pilot program impacts through the Massachusetts screening tool to consider societal cost effectiveness in terms of total resource benefits compared with total resource costs.

Total Resource	Present Value		PV of Net	Benefit-Cost
	Benefit	Cost	Benefits	Ratio
1 Green homes without solar water heating				
Program Total	$4,996	$5,350	$(354)	0.93
Non-Measure		$1,000		
Total Measure	$4,996	$4,350	$646	1.15
2 Green homes with solar water heating				
Program Total	$4,955	$6,600	$(1,645)	0.75
Non-Measure		$1,000		
Total Measure	$4,955	$5,600	$(645)	0.88

The results show that without solar water heating (labeled program 1) The savings measures on their own pass the screen, and show positive net benefits of $646, however the benefits are not adequate to cover the program costs, (estimated at $1,000 per house to administer the program) resulting in an overall program benefit-cost ratio of 0.93.

The results further show that with solar water heating (program 2) neither the measures nor the program pass the cost effectiveness screen.[1] [2] Again, it is critical to reiterate the size of the pilot, only four homes, and the inaccuracy of the cost information in considering our findings. Societal cost effectiveness screening is beyond the scope of this project. If this information were to be used to determine future program viability, we recommend further analysis of the screening assumptions used here.

V. Non energy benefits

Residential green building programs and standards typically include a host of strategies materials and methods that fall under the following general headings:

- Siting and land use;
- Building design;
- Materials and resource use;
- Energy and water use;
- Indoor environmental quality; and

[1] Regarding screening tool use; we conglomerated all savings data and created one average house to analyze. We used a 20 year measure life as an average aggregate of all savings measures. We did NOT calculate a weighted average measure life weighted by the benefits associated with individual measures. If further analysis were to be performed, we recommend screening each of the end use components with appropriate load shapes.

[2] Water savings estimate: an ENERGY STAR washing machine save 4413 gallons/yr (Efficiency Vermont Technical Reference manual.) All houses reported using this technology. We captured the savings from the composting toilet and the xeriscaping from the following information sources: Water use information from the Town of Shrewsbury, MA sewer and water department. (We presumed 2 people per house, 4 flushes per person, and 1.6 gallons per flush) and 40 gallons per day outdoor water use. We then spread these savings over the 4 houses and came to an average annual water savings of 9213 gallons/year, which we considered a conservative estimate.

- Homeowner awareness.

Costs, and perceptions about costs, are typically one of the largest hurdles to adoption of green building practices. In calculating costs and benefits of green construction, the easiest items to monetize are those related to energy. However there are many benefits of green building beyond energy savings, some of which are more difficult to quantify. In relation to these four pilot houses, some of the non-energy benefits (NEB's) include the following:

- Siting and Land Use – siting on an existing site, reduced lawn area, lawn mowing and water use, site impacts (i.e. protecting root zones, ecological preservation…);
- Building Design – solar orientation, multi-use spaces, daylight strategies, smaller house size;
- Quality/Durability - flashing details, long lasting materials with commensurate warranty, stainless fasteners, these equate to maintenance savings, occupant health;
- Occupant health and IAQ - non-toxic materials selection, proper ventilation, reduce introduction of outdoor pollutants, sealed ductwork, amounting to reduced health care costs, higher productivity and occupant happiness;
- Resource impacts -recycled/ reused products and materials, advanced framing techniques, engineered lumber, local materials, waste reduction, etc. These equate to the numerous societal benefits associated with minimizing overall impact of construction;
- Reduced emissions – reduced need for combustion of fossil fuels and the resulting emissions into the atmosphere;
- Occupant education (Owners manual, photo-journal of construction, properly functioning mechanicals.) This practice saves time and money for the homeowner for years after construction, and helps ensure the proper functioning of mechanical systems;
- Personal integrity/ consistency of word and deed. This is very important to many home owners and home buyers. "We all like to think of ourselves as people who care about the environment. It is time we started building that way!"
- Improved quality of life, "The joy of living". Overall homeowner happiness; and
- Comfort, as a result of well sized, properly distributed and responsive heating and cooling systems.

Research has demonstrated consumer indifference to energy savings alone. In order for a green building program to stand on its own merits, there is a need to monetize non-energy benefits. Considerable work has been done in this area, and more needs to be done. Specifically some of the more easily quantified NEB's are:

- Property value increase and salability;

- Reduced litigation expense;
- Reduction in mold and mildew risks; averted health and building maintenance expenses;
- Productivity – level of education, increased salaries, reduced incarceration rates;
- Durability – averted maintenance;
- Promoting in-fill development; and
- National security, reduce foreign dependency.

Participant perceptions of costs and savings and the value of non-energy benefits are summarized in the following quotes:

- "I know of nothing I would eliminate to save money as it all adds to the comfort and energy efficiency of the building."
- "We think that the marginal added costs are more than offset by lower energy bills and quality of life. Even the PV has a 10 year payback period, so we see it not as an expense but an investment. We just bought all our energy up front!"

VI. Residential green building standards going forward

The Cape Light Compact's residential demonstration project utilized the Vermont Built Green checklist as the standard for the four pilot homes. The Vermont Built Green (now Vermont Builds Greener) checklist has been updated and edited since CLC used the VBG checklist with the participants at the beginning of the pilot. In addition, a guidebook has also been developed which describes each approach in more detail, defines the rationale behind each approach, and lists resources available to help individuals achieve each approach. The guidebook, like the checklist, is an on-going work in progress and the VBG Committee has not had an opportunity to fully review nor update the checklist or guidebook's contents over the past two years.

While the VBG checklist was being used as a guide for builders, architects and homeowners on Cape Cod and in Vermont, the USGBC (United States Green Building Council) was using the checklist as a guide to develop a national residential green building standard, LEED for Homes. The resulting LEED (Leadership in Energy and Environmental Design) for Homes Green Building Rating System® is a voluntary, consensus-based national standard for developing high-performance, sustainable residential buildings.

When the USGBC took a new approach and requested local and regional organizations to provide technical, marketing and verification support to builders throughout a pilot phase, the Vermont Builds Greener Committee and VEIC decided to pursue becoming a LEED for Homes pilot provider. Both organizations felt that the LEED for Homes standard was similar enough to

the VBG standard that they could begin utilizing the LEED for Homes checklist and supporting documents to provide a dual certification for VBG and LEED for Homes.

VEIC spent a great deal of time comparing the various residential green building standards available to residents of Massachusetts through our work developing the Green Homes Northeast (GHNE) residential green building standard. Through that project, we determined that there was a great deal of overlap between the VBG and the LEED for Homes checklists. A few notable features incorporated in the LEED for Homes checklist include a house size factor, a comprehensive durability checklist and a foundation in the ENERGY STAR Homes program. Both VBG and LEED categorized their checklists using similar focus areas including siting and land use, indoor environmental quality, energy use, resource impacts, and homeowner awareness. In addition, an opportunity was provided in both VBG and LEED for Homes to achieve points/credits for approaches that were not listed but met the goal of the program.

The analysis and comparison of green building programs in the development of the GHNE standard also identified some differences between LEED for Homes and VBG. While both programs factored in house size and penalized larger than average homes similarly, VBG awarded smaller than average homes more points than LEED for Homes. VBG also requires that homes not be built on prime agricultural land, 100-year flood plains, wetlands and critical wildlife habitat while LEED for Homes has these as optional. There are also a number of durability approaches required in VBG that are optional approaches in LEED for Homes such as a minimum 25-year roof warranty requirement in VBG. There are several other approaches required in VBG but not LEED such as non-mercury thermostats; keeping mechanical equipment accessible; and insulating ducts to at least R-7.5 when run in outside walls. At the same time, there are requirements in LEED for Homes that are optional or not listed in VBG including leaving 40% of the lot undisturbed; installing permeable material for at least 65% of the lot; sealing off ducts during construction; and minimizing construction waste to less than 2.5 lbs per square foot of conditioned floor area.

Through this pilot, the VBG Committee has been working with the USGBC to set up a protocol which will allow State's to regionalize the LEED standard. There is a need for the USGBC to recognize regional concerns or issues that are not sufficiently addressed in the LEED for Homes standard. The VBG committee feels there is also a need to maintain an optional more rigorous or stringent standard or requirement that encourages environmentally conscious builders or homeowners to strive for and be recognized for a higher standard of green building.

The VBG Committee shall determine issues or elements of specific concern that it feels the LEED for Homes checklist does not adequately address; it shall establish added or altered criteria that address these; and it shall work with LEED for Homes personnel to addend or integrate these criteria into the VBG / LEED for Homes standard here in Vermont.

As the Cape Light Compact moves forward with a green building standard, we recommend that it consider taking the same approach as VEIC and the VBG Committee and utilize the USGBC's LEED for Homes program. We believe this is a great opportunity to reduce market confusion, utilize the strong brand name and resources of the USGBC, and support an effort to shift the current residential home building industry towards more sustainable practices. Currently, there are over 19,000 LEED Accredited Professionals supporting the commercial building industry, many of whom also design or assist residential projects in some capacity. As a LEED accredited certification becomes available for residential projects, we believe there will be a large support network for homeowners and builders who want to design and build LEED certified homes. Positioning the Cape Light Compact now for the inevitable green building marketplace will give the Compact and it's customers a head start in the future if residential construction while working to minimize environmental impact on the Cape and its surroundings.

VII. Conclusions

Builders feel there is pent up demand for green building in the residential sector. A recent zero net energy home workshop on the Cape with no advertising, was overflowing with participants. As one builder on the Cape put it, "It is amazing sometimes what an easy sale this is. Who is going to say I don't want a healthy house, don't put that in the budget. I can't afford this." We see education as the primary barrier to wider spread understanding and adoption of green building practices. Once the market understands what is meant by "green" and knows how to value it appropriately, green building will be on a trajectory to becoming standard practice. Programs like that offered on the Cape are necessary to meet the demand for information about this burgeoning field.

The Pilot Houses

Builder: Peter Wade; Location: South Orleans, MA

- VBG – 245.5 pts.
- House Size - 83 pts.
- Total – 328.5 pts.
- HERS – 91.5 pts.

Example of approaches achieved:

- In-fill development
- Restoration of damaged ecosystem
- Permeable paving driveway
- Optimal Value Engineering
- High-quality lighting design
- Dedicated Home Office

Builder: Habitat for Humanity; Location: South Chatham, MA

- **VBG – 133 pts.**
- **House Size - 175 pts.**
- **Total – 308 pts.**
- **HERS – 91.0 pts**

Example of approaches achieved:

- **Deed-protected affordable housing lot**
- **Restoration of damaged ecosystem**
- **No air conditioning installed**
- **No carpet in the house**
- **Engineered roof framing**
- **Cellulose installed in walls and ceilings**

Builder: Habitat for Humanity; Location: South Chatham, MA

- VBG – 133 pts.
- House Size - 175 pts.
- Total – 308 pts.
- HERS – 91.0 pts

Example of approaches achieved:

- Natural-based product for finish siding and trim
- Space provided for recycling
- Landscape that requires no irrigation
- No old growth wood used
- Low-VOC paints, solvents and adhesives

Builder: Bruce Torrey; Location: East Falmouth, MA

- VBG – 184 pts.
- House Size - 127 pts.
- Total – 311 pts.
- HERS – 90.7 pts

Example of approaches achieved:

- Previously built-on site
- Landscaped with wildlife enhancing species
- Permeable paving driveway
- Mudroom
- Solar water heating
- Hydronic distribution designed and sized to match room-by-room loads
- Salvaged and recycled materials used