Zero Energy Now: 60%+ Total Energy Savings in Existing Buildings

Gabrielle Stebbins, Energy Futures Group
Tom Perry, New Leaf Design
Richard Faesy, Energy Futures Group

ABSTRACT

Existing buildings represent one of the largest potential energy and greenhouse gas reduction opportunities available, and yet few programs have been able to extract more than 15-20% savings. In 2016, the Building Performance Professionals Association of Vermont (BPPA-VT) launched the Zero Energy Now (ZEN) pilot program, focusing on an optimized combination of weatherization, heat pumps, and solar PV to significantly minimize a home's reliance on fossil fuel. In twenty-four projects completed, the program delivered an average measured fossil fuel and electric grid savings of more than 60%, a level of performance rarely achieved through other programs. This paper presents an analysis of the savings results and how they were realized, the project costs to the homeowner along with an examination of the "financeability" and affordability, and a discussion of the future of a ZEN program in Vermont and beyond. The "general contractor" model for bundling the program elements, and other key components such as modeling software, a savings guarantee, incentives, and contractor recruitment and coordination are also addressed.

Introduction

Significantly reducing energy consumption in existing buildings is both a critical step in reducing greenhouse gas emissions and also exceedingly challenging (Wendt, 2007; DOE, 2010). In 2016, BPPA-VT developed and implemented the ZEN program, a building retrofit program designed to drastically reduce greenhouse gas emissions in existing residential-type buildings. By 2018, thirty-five projects incorporating weatherization, highly efficient mechanicals (heat pumps[1], heat pump water heaters and/or efficient, advanced wood heating systems), and renewable electricity generation, had been completed. Weather-normalized analysis of pre- and post-project fuel records[2] revealed an average of more than 60% fossil fuel and grid electric savings.[3]

---

[1] The vast majority of the projects incorporated cold climate air source heat pumps; however one project did incorporate a geothermal heat pump.

[2] While 35 projects were completed overall, only 24 homes were included in the analysis due to limited data for the remaining 11 projects. All data results presented reflect the results from these 24 homes and not the 35-project total.

[3] Within the ZEN program, "fossil fuel and grid electric energy" is defined as energy which includes all combustible fossil fuel products – refined liquid fuels, natural gas, and coal – and electricity that is sourced exclusively from the grid. All electricity renewably produced on site or produced by an exclusively purchased participation contract with a community solar or wind installation are recognized as renewable (as is wood fuel for heating purposes). In Vermont, renewable generation can be credited to the meter over the course of a year. Non-fossil components of liquid fuels such as biodiesel, corn, or sugar-based additives, and any renewable power within the system grid (e.g. utility-scale wind) were not credited. The authors are aware that the definition of "renewable" is debatable.

In addition to the goal of achieving "deep savings", ZEN also incorporated and bundled other program elements including connections to financing, solutions customized to each property incorporating unique program standards, a savings guarantee, building modeling tools, program implementation and reporting, and a "ZEN general contractor" who guides the customer throughout the program and coordinates all subcontractors. Each program element attempted to address a market challenge or failure: customer confusion as to what to do ("Insulation? Solar? Heat Pump?") is answered by the ZEN contractor; concerns about high project costs are lessened by optimizing efficiency with renewables; concerns about upfront costs are addressed through financing; and concerns that the cost is not worth the investment are addressed via a combination of the modeling tool and savings guarantee. This comprehensive approach to individual projects and overall program design is intentional; a goal of ZEN is to avoid the haphazard, circumstantial approach that occurs when the market is "left to its own devices."

While the initial results are impressive, areas of improvement are discussed below.

Background

Vermont has one of the most aggressive suites of clean energy goals (EAN, 2020) in the United States. The state has set expectations high: while we have missed the goal of weatherizing 80,000 existing homes by 2020, we continue to strive towards other goals such as zero-energy new construction codes by 2030 and 90% renewable energy for all sectors by 2050 (Vermont DPS, 2016). To accomplish this, Vermont needs a thriving, eager and savvy home performance workforce to deliver results in the thermal sector.

In 2015, BPPA-VT secured funding from the state's largest utility, Green Mountain Power (GMP), to pilot "Zero Energy Now," a comprehensive, integrated "deep savings" approach that was implemented in the following year. For each participant, the minimum program standards required a 10% reduction in the use of energy (e.g., through weatherization), a 50% reduction in the use of fossil fuels (achieved predominantly through weatherization and heat pumps) and grid electricity[4], and that 50% of household energy consumption is met by the use of renewables on-site (also referred to as "10-50-50").[5] The program utilized available efficiency incentives and tax credits and provided an additional bonus of up to $5,000 per project.

The initial ZEN program, implemented in 2016, was modified in 2017; to differentiate the two offerings, BPPA-VT renamed the 2017 initiative the "Solar Bonus" program. The programs differed in incentives and project standards.[6] However, both ZEN and Solar Bonus involved a bundling of technologies (weatherization, efficient mechanicals, renewables) and also a bundling of comprehensive program elements, as depicted in Figure 1 below.[7] The remainder of this paper discusses the successes, challenges and learning opportunities for each of the key program design elements shown in Figure 1.[8]

---

[4] While Vermont's electric grid is generally more "renewable" than many states, it is still not 100% renewable; hence, the goal to reduce demand for grid electricity as well as fossil fuel consumption.

[5] "Renewable" is defined as renewable electric (solar, wind, micro-hydro power) or as biomass energy (woodchips, pellets, cordwood). Efficiency and air quality standards were required for wood heating systems.

[6] Solar Bonus provided up to $1,000 rather than ZEN's $5,000 and required a 10% reduction in air infiltration *or* meeting a maximum 3.00 ACH at 50cfm, *and* 50% reduction in fossil fuel usage only, rather than ZEN's 10-50-50.

[7] For greater detail regarding the program implementation (e.g. timeline, marketing and sales, contractor training, reporting, and detailed incentive structures) see Perry, 2020.

[8] While we include non-energy benefits in Figure 1 to highlight their existence, this paper does not explore them.

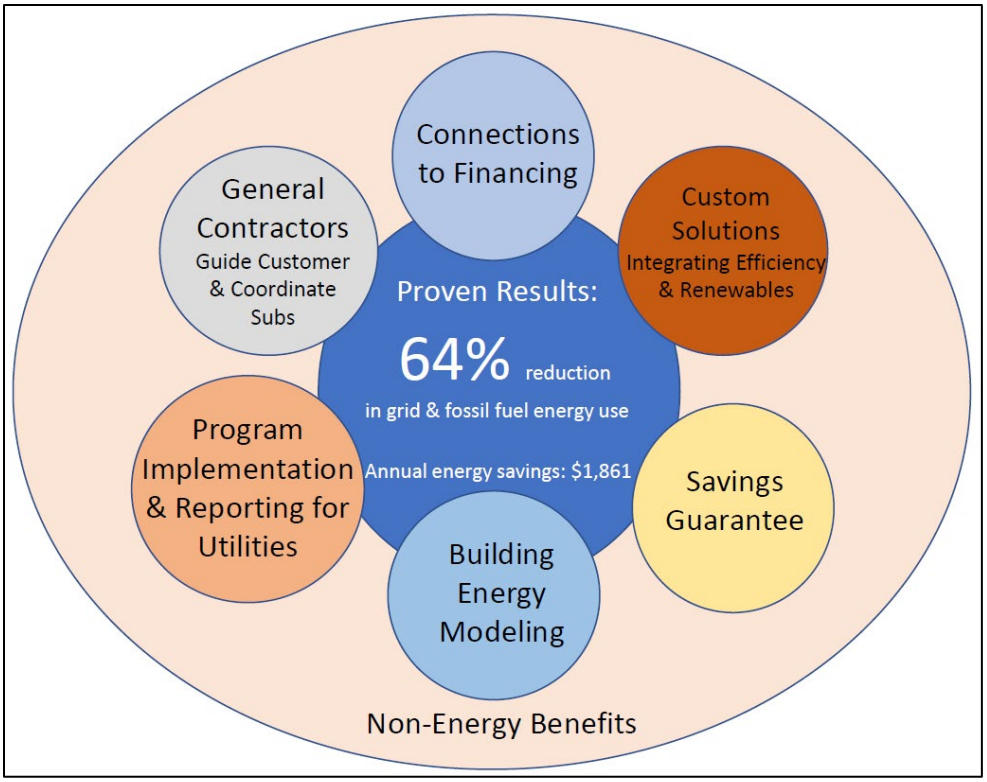

Figure 1. Zero Energy Now and Solar Bonus program elements.

Program Results and Findings

While a total of 35 projects were completed in the two pilot programs (22 ZEN and 13 Solar Bonus), the detailed data analysis that is presented in this paper was completed for only 24 projects due to limited data and customer access for 11 of the projects. Collectively, these 24 projects delivered total energy savings[9] averaging 39%, and fossil fuel and grid electric (F&G) savings averaging 64%. Energy cost savings were similarly robust, with cost savings ranging from 25% to 96%, an average savings of 60%, and median savings of 51%. Generally, participants and contractors found both programs to be valuable and beneficial, though some offered areas for improvement, e.g., regarding the modeling tool, program marketing[10], homeowner education and training, and contractor follow up.

[9] "Total energy" is defined as the entire energy consumption of the house and its occupants, combining all fuels used: electricity, combustible liquid fuels (kerosene, #2 fuel oil, liquefied petroleum gas), combustible natural gas, and combustible solid fuels (cord wood, wood pellets, or coal). Sourcing of fuels, especially whether the electricity is renewably sourced through solar, wind, or hydroelectric systems is not considered in this definition.

[10] The ZEN marketing budget in 2016 (~$80,000) was used for developing a logo, brand, website, and program brochure to then be leveraged by contractors, non-profit and utility partners, and via earned media. Nearly 50% of the completed projects were "brought in" through contractors rather than, say, paid advertising (of which there was none, given the short time frame for program implementation and budget limitations). Contractors felt program marketing could be improved in the future.

In the next section, we first present the results from one specific project (#3) to highlight the ZEN approach in a detailed fashion, after which we present findings for all 24 projects in aggregate.

Savings Results and Findings

Figure 2. Project Three photograph.

Size of house:	1688 sq ft	
Style of house:	Raised Ranch	
Number of Occupants:	4	
Net Project Cost:	$16,142	
	Pre-Project	**Post-Project**
Fuels Used:	Oil, LP, kW	LP, kW
Envelope/Mech. Load:	59.02	46.95/33.57
Domestic Hot Water:	20.43	5.11
Total Energy Consmd:	120.56	60.50
Solar Array:		7.8 kW
Solar generation:		32.64 (9567)
Other Renewable:	41.99	24.11
Fossil & Grid Total	78.57	3.75
Annual Energy Costs:	$2,655	$359
Monthly OP	$221.29	$138.72

Figure 3. Project Three site description.

Project Three, a raised ranch shown in Figure 2, provides an overview of the ZEN approach to reducing energy consumption and switching from fossil fuels to on-site renewables. It is the second most successful project regarding energy savings and the least expensive project included in the analysis. Extensive weatherization (attic, basement, and exposed framed walls in the basement) reduced the heating load by 20%, a heat pump further reduced heat load by 23%, a heat pump water heater replaced 223 gallons of propane (or ~20MMBTUs of propane) with 5 MMBTUs of electricity, and a 7.8 kW solar array meets nearly all load. Propane (for cooking) is the only remaining fossil fuel use. Cord wood use was cut in half. With a twenty-year, 5¼% loan, the homeowner's monthly cost is $82 less than pre-project costs, as shown in Figure 3 as "Monthly OP" (monthly operating cost). Detailed results are shown in Figures 4, 5, and 6.

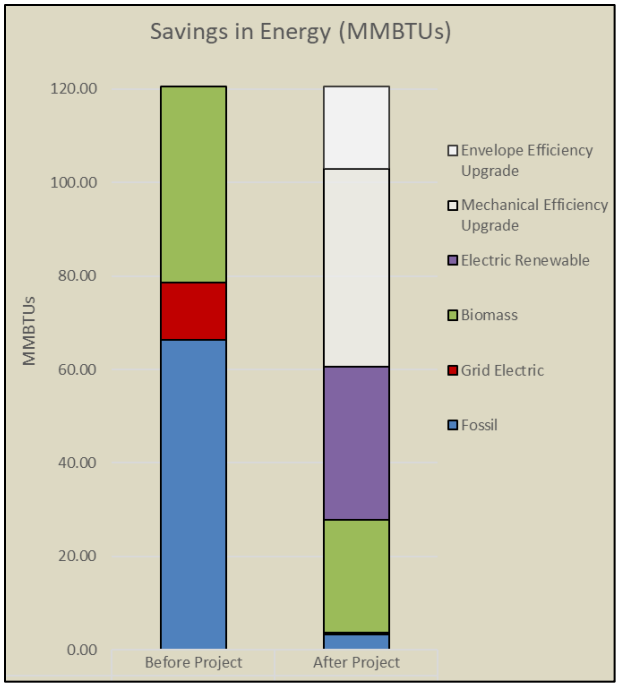

Figure 4. Annual energy savings

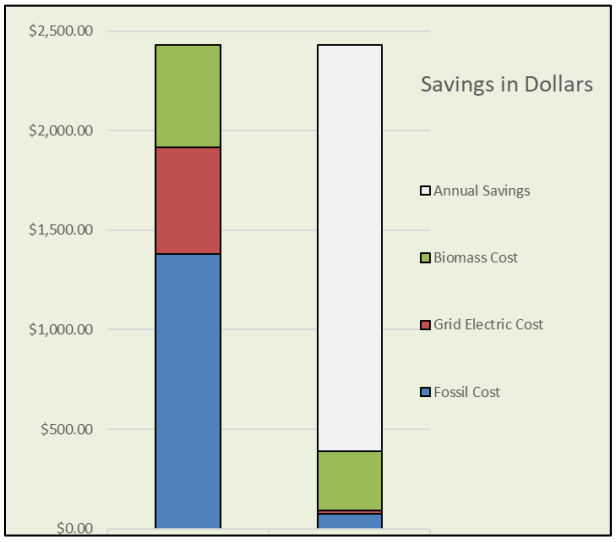

Figure 5. Annual cost savings

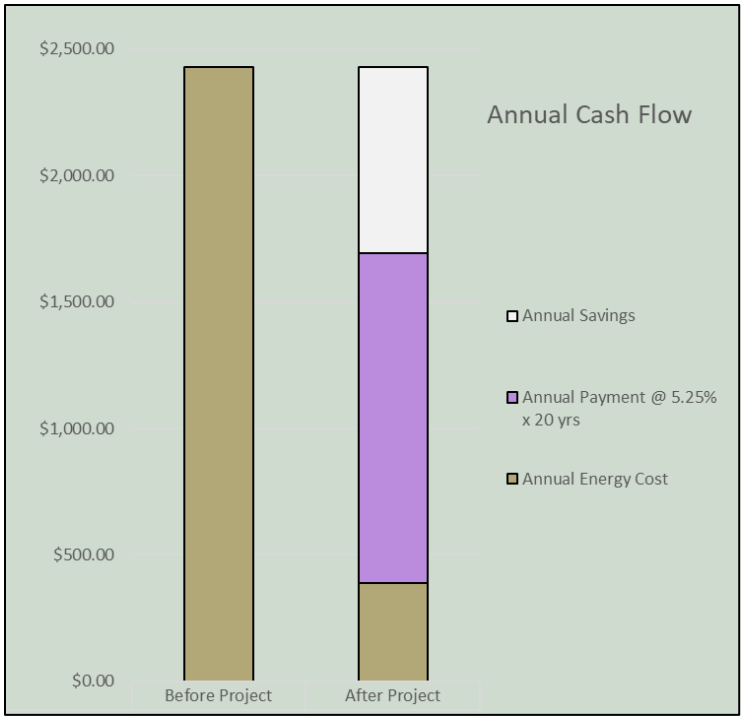

Figure 6. Annual cash flow.

Figure 7, below, shows the energy savings for the 24 installations included in this paper.[11] Thematic changes are similar to Figure 4: high pre-project fossil and grid-sourced electricity consumption shown in the left bar is significantly reduced by envelope efficiency improvements, efficient mechanical upgrades, and the installation of renewables to substantially meet the load. The pre-project energy upgrade opportunities available varied; some projects realized dramatic envelope savings (Projects #16, #21, #25) while others saw a greater change in renewability (#3, #32, #33, #35). Projects 6 and 18 show substantial renewables before and after due to heating with wood both pre- and post-project.[12]

[11] For legibility, Figure 7 combines renewable energy sources (e.g. solar generated electricity and biomass) together, as well as fossil fuels and grid electricity together, while Figure 4 does not. This explains the high levels of "renewable energy" in some of the pre-project bars, reflecting the significant role wood plays in Vermont's heating sector.

[12] Note that wood fuel usage dropped 25-50% through the installation and use of cold climate air source heat pumps.

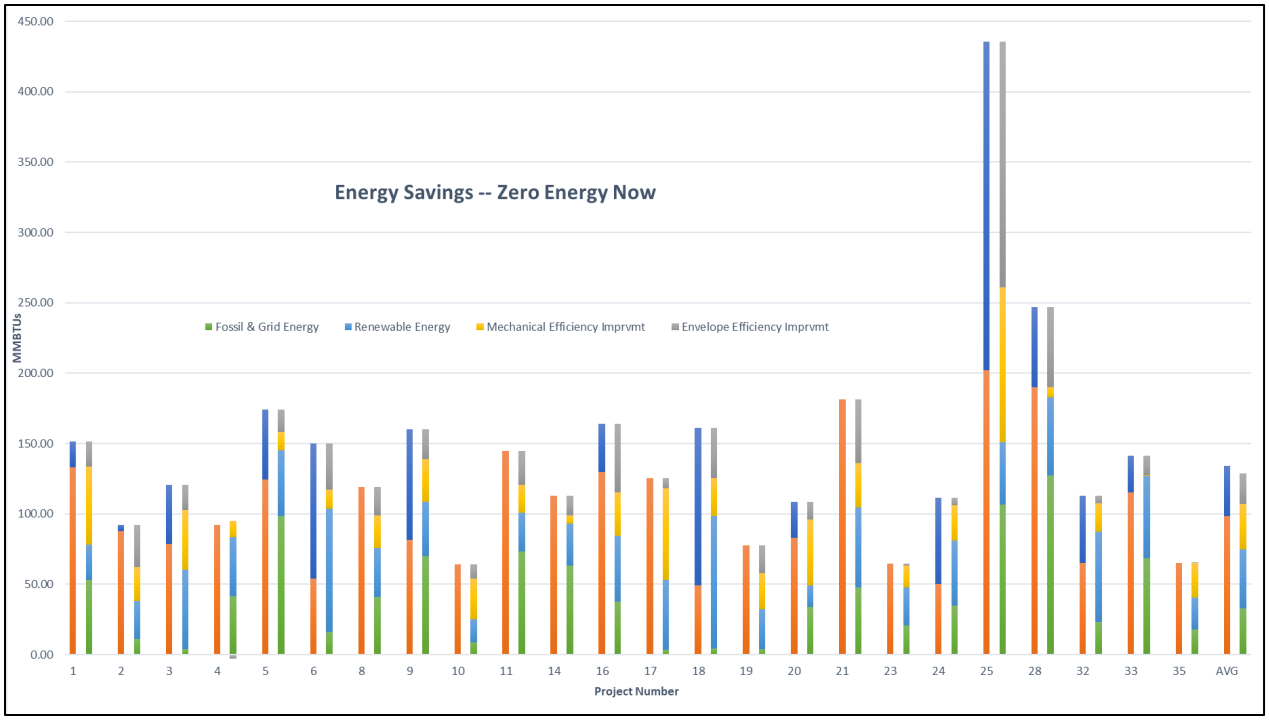

Figure 7. Energy savings for 24 ZEN/Solar Bonus projects.

A review of fossil fuel savings also shows significant benefits. Figure 8 below shows ten projects reduced their fossil usage by 90% or more (10 and 23 cut fossil fuels entirely). For nine projects, fossil fuel usage dropped to less than 10% of total energy consumption.

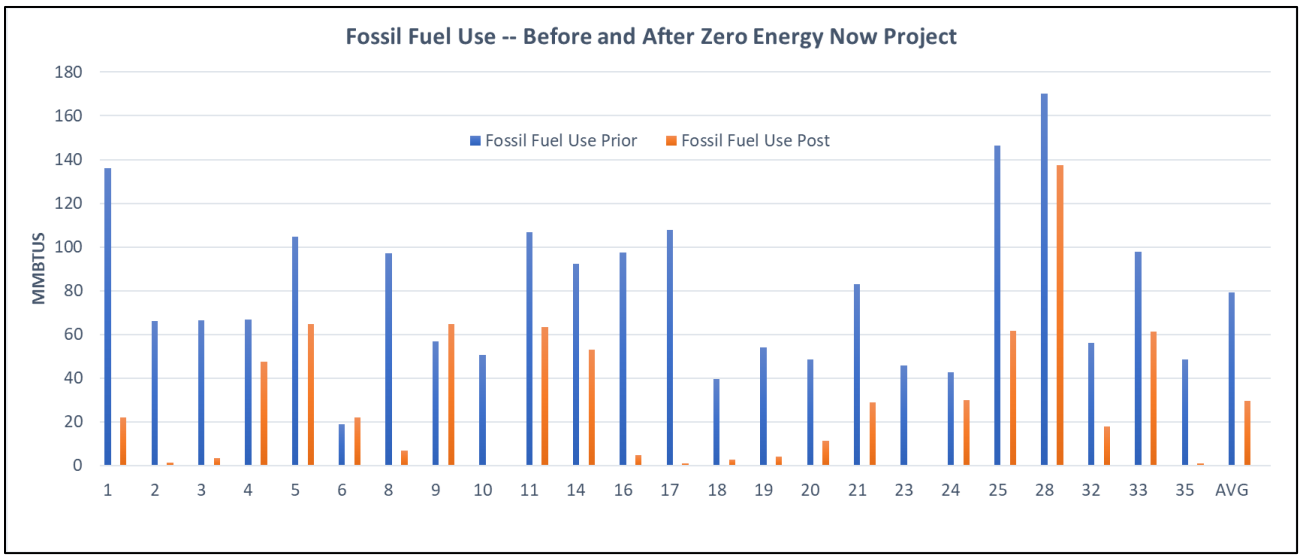

Figure 8. Fossil fuel use before and after ZEN improvements.

Connections to Financing: Findings and an Exercise

While none of the ZEN general contractors provided financing to the homeowners through their building contractor business (for example, as some heat pump installers do), all were aware of the available incentives[13] and financing products[14] and were trained to present these to homeowners as part of the sales process. With an average ZEN project cost at over $54,000 (~$41,000 after incentives) financing, the project was critical for many homeowners.

The interplay between project cost, estimated energy cost savings, and a homeowners' willingness to go into debt was challenging to discern and quantify. Intuitively, it could be inferred that, if the post-project energy costs *plus* the financing payments resulted in the same (or less than) pre-project energy costs, homeowners would be more willing to invest in the upgrade (particularly with the confidence provided via the Energy Savings Guarantee). Unfortunately, "hindsight is 20/20"; the customer surveys did not probe this area of questioning.

However, due to anecdotal conversations with some of the customers, contractors and local lenders, we do know that many of the homeowners *did* utilize financing products to complete the projects; whether the "balancing act" of pre- and post-project combined costs helped alleviate concerns about going into debt remains unknown. As will be discussed later, cost was not the primary driver for many early adopter ZEN and Solar Bonus participants. However, this is generally *not* true for Vermonters, given strong debt aversion (Stebbins, 2018).

While some people can afford to do ZEN without financing, the program was not intended to be a boutique option for environmentally minded high-end homeowners. The goal is for ZEN to be a robust, compelling engine of broad-scale change. Without the ability to verify considerable energy cost savings (thereby increasing market confidence in both the investment payoff and ultimate financeability of the project), scaling up ZEN is likely to be challenging.

As a result, we examined this interplay between costs, savings and financeability to try to assess the long-term affordability of ZEN. Specifically, we reviewed a variety of loan products available in the region to identify the option with the lowest possible monthly payment. At the time, it was a home equity loan at 5.25% with a twenty-year term provided by a local credit union with energy savings inherent in the union's mission statements.[15]

Using a 5.25% rate and twenty-year term, we assessed the "affordability" of the 24 projects to determine how many projects resulted in a monthly positive, neutral or negative cash flow for the homeowner. Specifically, the *monthly energy cost* pre-project was compared to the *monthly energy cost plus loan payment* post-project. The results of this analysis are provided in Figure 9. Ultimately, four projects were cash flow positive (# 2, #3, #6, #33) while four projects required only small additional monthly outlays ($17, $23, $30, and $33). These results are likely to vary. First, they do not include non-energy benefits and, depending on future fuel prices,

[13] Efficiency Vermont incentives (up to $2000) were based on specific air sealing and insulation improvements; the ZEN incentive was $50/MMBTU of combined fossil fuel and grid electric energy saved not-to-exceed $5000; the Solar Bonus incentive was $188/kW of installed solar not-to-exceed $1,000 ($188/kW is approximately equivalent to $50/MMBtu). Rebates for heat pumps, advanced biomass equipment and solar hot water were fixed amounts based on equipment purchased. Federal tax rebates for solar and other energy improvements varied but were based on a percentage of project cost.

[14] Financing products in Vermont include personal and energy loans, home equity lines of credit, and re-financing mortgages.

[15] The authors recognize that other products may be available to some homeowners (such as refinancing a mortgage) and that interest rates vary; while writing this paper the Federal Reserve lowered the target range for its federal funds rate to 0-0.25% due to economic impacts resulting from the coronavirus. Nevertheless, utilizing a rate such as 5.25% provides a useful framework for the purposes of the intellectual exercise assessing ZEN's "affordability".

inflation rates and other variables, financial savings could be less or more than the findings from this study. The detailed review suggests the following factors to be critical in realizing expected savings: depth of energy savings, the degree to which the solar array covers the load, as well as the accuracy in sizing equipment to building loads (Perry, 2020). Finally, a critical factor in optimizing heat pumps rests in the homeowner operation of the various equipment (Perry, 2020).

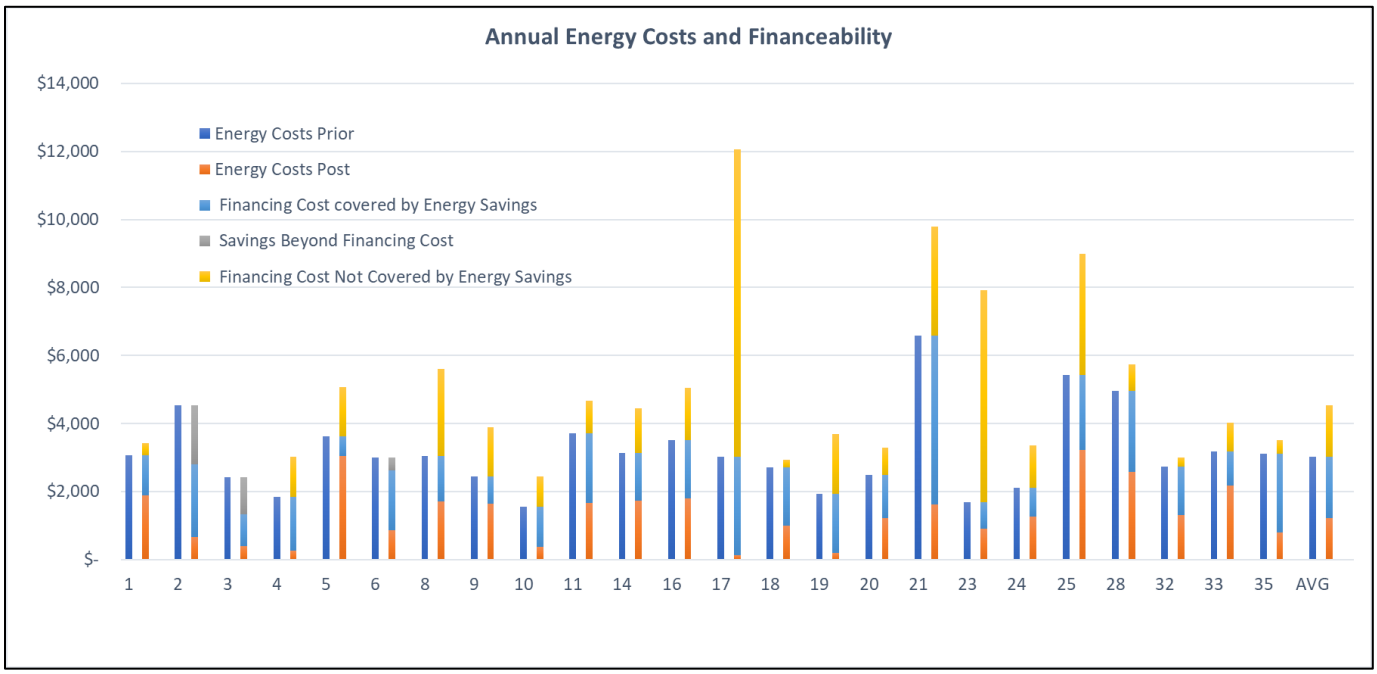

Figure 9. Annual energy costs and financeability.

Ultimately, the ability to complete a ZEN or Solar Bonus project will rest, perhaps precariously, on the following factors:

- the potential energy upgrades inherent in an existing building,
- the homeowner's ability and willingness to invest time and money in a project of this magnitude,
- the incentives and financing products available to the homeowner, and
- the contractor's ability to communicate not only the value and benefits of these projects, but also to assist in guiding the homeowner along the project pathway.

Custom Solutions: Homeowner Satisfaction Findings

Homeowners were surveyed twice: via an online SurveyMonkey in 2017, just after the 2016 ZEN program had been concluded to meet grant requirements and via phone interviews in 2019. In both sets of surveys, homeowners were asked a range of questions, including:

- what motivated them to participate,
- their experience with contractors and equipment,
- their sense of the overall project performance regarding comfort, energy savings and cost savings, and
- which "entry point" brought a homeowner to the ZEN/Solar Bonus program.

Figures 10 and 11 and Table 1, present the survey results (in the figures, the larger the circle, the more frequently the word/s were mentioned by the interviewee).[16] Of the twenty people who received phone interviews, most expressed solidly positive reflections on the program as a whole. Table 1, below, shows homeowner motivation to participate (note the minimal driver "save money" plays). Figure 11, below, shows key areas driving satisfaction: comfort, being part of the climate change solution, getting off fossil fuels and owning solar.

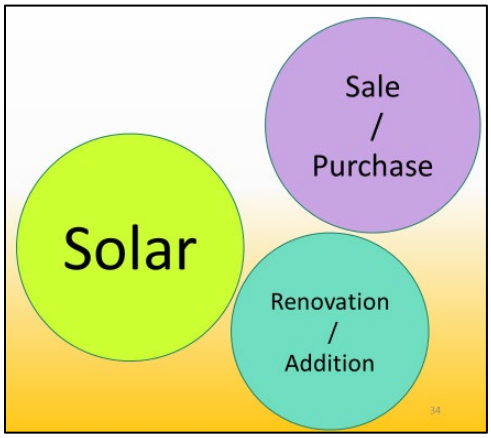

Figure 10. Customer entry point.

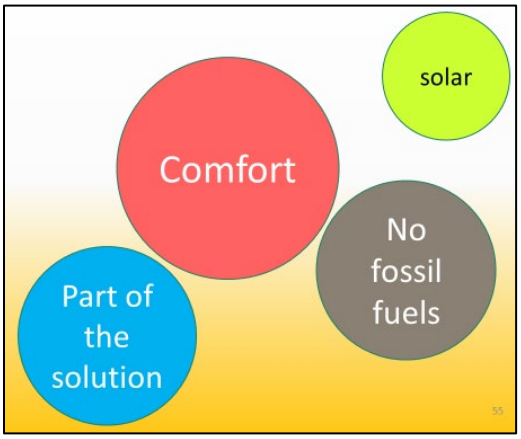

Figure 11. Customer satisfaction.

Table 1. Customer motivation.

Top Reasons Mentioned for Doing a ZEN Project (20 responses):	
1. Get off fossil fuels:	10
2. Improve house:	7
3. Save money:	3

Three themes emerged when asked in more detail about weatherization, solar, and heat pumps.

First, homeowners continue to be unsure about how to operate heat pumps efficiently and effectively. They stated they received "no" education about how to use them[17]: "Learning to live with heat pumps was complicated, but in the past now." Furthermore, some participants continue

[16] Contractors found that homeowners who began the ZEN project discussion from a "I want solar" entry point were far more likely to incorporate the other ZEN components (weatherization and efficient mechanicals) as compared to the homeowners who began with "I plan to do some air sealing" entry point. This is not surprising, perhaps, as the homeowners considering solar at the start already had an expectation of investing several thousands of dollars while those considering a smaller project initial, may have been planning on a smaller investment.

[17] The training provided to the contractors at the outset of ZEN and Solar Bonus included guidance on how to explain heat pump operation to homeowners. It is unlikely that the statement that homeowners received "no" training regarding heat pump operation, given that the contractors working within ZEN/Solar Bonus certainly provided basic operation information. The real question is: "Is the training sufficient?" to which the answer appears to be, "no."

to perceive heat pumps as a "shoulder season" heat source only: "I think we are still in the mindset that the heat pumps are primarily for three seasons and oil for the winter." A detailed review of the 24 projects revealed that, indeed, some homeowners could be using their heat pumps for a greater part of the year as well as more efficiently (Perry, 2020).

Grant requirements resulted in (effectively) limiting the program to seven months in duration.[18] This resulted in a few projects being expanded to meet ZEN requirements after, for example, having already installed solar panels.[19] Thus, our second thematic finding: that it is critical to match load to solar generation to achieve optimal energy and cost savings.

Perhaps unsurprisingly, the third (and arguably most important) theme to emerge from the overall interview results was the need to manage customer expectations clearly. Integrally related to "managing customer expectations" is the need to ensure that homeowners clearly understand how their new home should operate, as well as how to use their new equipment so they can identify whether there are (or are not) performance issues that need to be addressed. For participants who were dissatisfied with specific elements of the program, and for the two who were dissatisfied with the overall project results, often their lack of understanding resulted in an unrealistic expectation, leading to dissatisfaction (the need for contractor follow up post-project is discussed below).[20]

Homeowners' understanding of and experience regarding cost savings reveals similar trends. It appears that the initial high cost of the overall project blurs the homeowners' sense of their monthly cost savings: "I'm not saving money now because of such a big upfront cost" (paid for in cash), and "It depends on how you account for the money, but saving money wasn't a motivator because we're just trading costs" (i.e., expenses vs. investments). Also: "I expect there will be cost savings. Right now, there certainly is not, but I expect it to be a benefit in the future" (Perry, 2020). And for a particularly poignant example: "Expected lower bills; gain is no frozen pipes; but not financial gain". Review of pre- and post-energy bills for this site shows monthly energy costs dropped from $378/month to $54/month, but the homeowner's focus on the cost of the project superseded his ability to see the energy savings achieved.

While our questions did not specifically address income or wealth demographics, many participants discussed their financial capacities in response to other questions. Five or six homeowners were in upper-income brackets while two or three lived in their homes part-time; most participants live on a relatively moderate income. Many homeowners were distinctly frugal, expressing strong sensibilities about cost and value regarding their homes and energy; all clearly believed and understood the benefits of investing in their home now to limit future costs. While

---

[18] While BPPA-VT's grant proposal was accepted by the host utility (Green Mountain Power) in 2015, work could not effectively begin until regulatory approval occurred in February 2016. From February to May, program delivery services, contractor trainings, and marketing materials were developed and implemented for a program roll out in June 2016. Contractors had 7 months to develop and complete complex, integrated ZEN/Solar Bonus projects.

[19] The initial ZEN program goal was to complete 50 projects within 12 months (January – December 2016). With the program only "kicking off" in June of 2016, grantees felt an obligation to achieve as many projects as possible within the (shortened) 7-month programmatic time frame. As a result, participating ZEN contractors presented ZEN to existing customers, some of whom had already undertaken some steps towards ZEN, such as solar or heat pumps. This matters because it provides color and content as to both "who" the ZEN participants were (true believers) and the modeling results: if a homeowner began with solar and then expanded into a larger ZEN project, then the final savings (both energy and cost) may not reflect what could have been achieved if the project had been conceived – start to finish – from one, overarching perspective and set of goals.

[20] For example, one homeowner complained about overheating in the summer (heat pump operation issue?). Another stated she did not "mind keeping the thermostat at 55 and wearing a sweatshirt, but that" she wished "the house didn't have to be so cold". Another was disappointed that their solar generation didn't completely offset their load.

many of the homeowners were fiscally minded, when asked about how the project cost factored into their decision-making, responses included: “Less important than cash flow,” “ Looking to long-term benefits,” “Different prioritization,” “We didn’t do this for the energy cost savings.” Ultimately, most homeowners participated for a variety of reasons, including wanting to save money, to lessen their environmental impact (especially pertaining to fossil fuel usage and climate change), and to improve the comfort of their home.[21]

In sum: homeowners were generally very satisfied. Eighteen of the 20 interviewed participants were “delighted” with their specific project. When there were areas of dissatisfaction, they can usually be attributed to a lack of understanding from the homeowner (and perhaps the flipside: too little training and follow up by contractors), unmet customer expectations, and issues such as sub-optimal sizing of generation to load. The surveys also revealed that these initial ZEN participants happen to be early adopters and true believers. Certainly, ZEN promises significant energy and cost savings, but whether ZEN can capture the interest of the broader population remains unclear.

Savings Guarantee: Findings

ZEN and Solar Bonus both included an “Energy Savings Guarantee”[22], under the assumption that homeowners would feel more comfortable investing in a large project with potentially significant upfront costs if they knew they would realize the energy cost savings (even if it might take two decades). For this reason, both ZEN and Solar Bonus offered a savings guarantee in which, if the actual total energy usage was higher than the projected usage after one year, the additional dollars spent to pay for the incremental energy usage, would be refunded up to a maximum of $1,000 per participating property.[23] While none of the program participants made any claim on the guarantee[24], Figure 9 (provided earlier) suggests that some participants could have.[25] If the goal is to considerably scale up ZEN, then it is critical to minimize the variation between modeled versus actual savings. Not only could the savings guarantee become problematic and expensive, for the many projects that need financing, accurate savings projections is critical.

Building Energy Modeling, Program Implementation and Reporting for Utilities: Findings

As discussed above, the size and scale of ZEN projects require participant and lender confidence in the validity of the projected energy and cost savings for probably everyone except the true believers. Therefore, identifying what is needed in a building energy modeling tool and training contractors in the use of the tool becomes paramount to accurately estimate savings and develop financing proposals, as well as report savings for utility efficiency programs.

---

[21] Only one interviewee’s motivation was driven by one factor alone; it happened to be the financial benefit.

[22] Note that the savings guarantee was not provided by the contractors, but rather by the grantor. Anecdotally, the contractors that have participated in this program have not felt comfortable providing an energy savings or energy cost guarantee due to the considerable influence human behavior can play.

[23] The guarantee language specifies additional details such as the requirement to compare actual fuel usage from detailed bills and whether the number of occupants changed. Contractors also provided a quality guarantee.

[24] And, in fact, during the first online survey, many respondents couldn’t recall that a guarantee was available.

[25] For example, projects 9 and 23. However, by removing her wood stove, the project 9 homeowner did not maintain the system components understood in the work scope and therefore would not have qualified for the savings guarantee. In project 23, however, all the directives in the work scope were followed, and the reason for the shortfall in savings remains unknown.

While two different modeling tools were used for the pilots,[26] both tools produced similar expectations of savings (Perry, 2020).[27] For the 24 projects shown in Figures 7, 8 and 9 above, the average variance between projected and actual savings was 22%. Modeling for 5 of the projects came within 5% of actual savings and 11 were worse than the average variance of 22% while 3 projects were under-predicted. When the modeling was repeated in a more "controlled" manner,[28] the average variance between projections and actual savings improved to 16%. Two more projects (for a total of 7) came within 5% variance and 9 projects (rather than 11) were worse than the average variance (16%) while 4 projects were under-predicted.

While some of the variances were clearly due to the modeling process, others related to failings in the projects themselves or in homeowner operation of the heating equipment.[29] Similar to the overarching theme that emerged from the homeowner surveys, ultimately several program factors (e.g., homeowner training) need to be "tightened up" in order to increase ZEN project and program performance. This is discussed further below.

General Contractors: Contractor Satisfaction Findings

Although 16 contractors received ZEN program training, only nine completed projects. Six of these nine were surveyed.[30] The contractor assessment of the program was generally favorable and positive; all interviewees felt the program was well-aligned with their business goals. Constructive criticism was offered regarding specific program elements. For example, some felt that the learning curve for the modeling tools was too great for a time-limited program offering. All, however, saw the potential for the program and the longer-term value for their businesses. Some (mostly larger) businesses are more suited to scaling up within a ZEN program model than others, but the concept itself with its rigorous standards, strong building science foundation and comprehensive approach provides an important structure that a variety of contracting businesses find valuable.

All contractors agreed that the additional incentives gave significant impetus to homeowners to learn more about the program, to connect with a contractor who could deliver the incentive, and to proceed with their projects in a timely manner to obtain the incentive. The incentive also gave the program important credibility in the marketplace – both for the homeowner and for the contractors weighing its potential benefit to their businesses. All contractors said the $400 incentive provided to contractors once a project was completed was also important, particularly to help overcome the initial program learning curve.

Few utility efficiency programs focus on integrating multiple energy solutions in a comprehensive manner; the same can be said for the businesses that provide energy solutions. This was another learning curve for ZEN contractors. For example, ZEN contractors who were Building Performance Institute (BPI) certified and involved in the Home Performance with

[26] EUSAVE, developed by Parsec Energy and adapted for ZEN in 2016 and CLEAR developed by New Leaf Design for use in the 2017 Solar Bonus program.

[27] The average fossil and grid savings projected by EUSAVE was 83% for the 22 completed projects in the 2016 ZEN pilot. The average for CLEAR was 80% for the 13 projects in the 2017 Solar Bonus pilot.

[28] Specifically, the modeling was repeated using the CLEAR tool with pre- and post-project fuel usage carefully entered by one person in a format adjusted for heating degree days.

[29] For example, in the "controlled" modeling exercise, 7 of the 9 homes that varied more than the average 16% variation, involved issues related to use of the home or heating equipment. At this time, the cause of the variation in the 8th and 9th projects are unknown, but may be similar (e.g. driven by home occupancy and homeowner operation).

[30] Of the three not surveyed, the contractor conducting the surveys abstained from participating and two were unavailable.

ENERGY STAR® Program were generally adept at the building science component of ZEN, but many had something to learn about optimally integrating the other ZEN components such as solar or advanced heating systems. ZEN contractors with the least background in these other ZEN components relied fairly heavily on the expertise of their subs who sometimes did not fully understand the ZEN goals, which presented other challenges such as optimally sizing systems.

Besides the issues presented above, such as modeling and program timing frustrations, participating contractors were generally quite supportive and satisfied with the program overall. However, many of the participating contractors were already inclined to offer these types of projects. For contractors with business models that depend on an easy, "cookie-cutter", in-and-out sales and installation process, ZEN and Solar Bonus may not be a good fit.

Lessons Learned, Looking Forward and Conclusion

In many respects, the ZEN and Solar Bonus programs were phenomenal successes, achieving deep energy savings and significant cost savings resulting in additional, larger projects for contractors and satisfied homeowners. Nevertheless, improvements can be made.

Tactical improvements include: (1) identifying an intuitive modeling tool that limits user error while achieving high accuracy, (2) greatly increasing homeowner education and training regarding use and operation of their new equipment, (3) ensuring contractor follow up with customers to solve potential issues, (4) developing a program that is detailed enough to ensure real savings yet flexible enough to shift with changing market dynamics, and (5) attempting to limit issues outside of the control of the ZEN program (e.g. having longer than 7 months to complete jobs and increasing program marketing).

The primary question is "How do we scale ZEN?" The answer involves a myriad of interconnected needs such as:

- Ensuring the existence of ongoing incentives[31],
- Expanding marketing to reach those who are not early adopters or true believers,
- Improving accuracy in energy and cost savings to provide the confidence needed by lenders and customers, and
- Providing tools and training support to contracting businesses.

Indeed, in January of 2020, board members of BPPA-VT and the non-profit Northeast Energy Efficiency Partnerships (NEEP) secured additional funding to modify and scale up ZEN in Vermont and the Northeast region. This work is currently underway and will be informed by the findings from the 2016 ZEN and 2017 Solar Bonus pilots.

The need to address energy consumption in existing buildings is critical in mitigating climate change. BPPA-VT's ZEN and Solar Bonus pilots offer a solution. Program designers are expanding ZEN into a lasting program offering that can be utilized in Vermont and beyond.

References

Energy Action Network (EAN). 2019. *2019 Annual Progress Report for Vermont.* Montpelier, VT: EAN. https://www.eanvt.org/2019-progress-report/

[31] Alternatively, society could choose to include the external costs of fossil fuels within the price of fossil fuels.

National Renewable Energy Laboratory (NREL). 2010. "Gaps and Barriers Summary: 2010 Residential Building Energy Efficiency Meeting". Prepared for the U.S. Department of Energy (DOE). August 2010. Golden, CO: NREL. https://www.nrel.gov/docs/fy10osti/49162.pdf

Perry, T., Young, L. 2020. Zero Energy Now Pilot Programs 2016 and 2017 Project Study Report. Montpelier, VT. http://bppa-vt.org/resources/Documents/Zero%20Energy%20Now%20Data%20Analysis.pdf

Stebbins, G., E. Bergan. 2018. Vermont Clean Energy Finance Report. Montpelier, VT. https://publicservice.vermont.gov/sites/dps/files/documents/Renewable_Energy/CEDF/Reports/Vt._Clean_Energy_Finance_Rpt_2018.pdf

Wendt, A. 2007. "The Challenge of Existing Homes: Retrofitting for Dramatic Energy Savings." *BuildingGreen*, July10. https://www.buildinggreen.com/feature/challenge-existing-homes-retrofitting-dramatic-energy-savings.