MEMORANDUM

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RE: K-12 Energy Efficient Education Program Literature Review Findings

Introduction and Overview

This memo provides insights on K-12 energy education programs administered around the country. The goal of this research effort was to identify K-12 energy education programs that quantify energy savings and claim these savings in regulatory filings. As part of this effort, Opinion Dynamics conducted a literature review of K-12 energy education evaluations and identified six that quantified savings (two of which claimed these savings). We utilized PA knowledge of existing K-12 programs, as well as evaluation databases and clearinghouses such as the California Measurement Advisory Council (CALMAC) and the Consortium for Energy Efficiency (CEE) to identify evaluation reports for inclusion in this study. In addition, we conducted interviews with program staff administering programs throughout the country, including a representative of the National Energy Education Development (NEED) Project.[1]

In general, there are few programs that quantify energy savings and those that do, tend to give students take-home energy saving measures such as CFLs or make energy saving improvements to school buildings that have quantifiable energy savings (such as changing lighting controls).

Based on our review, current K-12 programs fall into four categories:

1. Curriculum-based offerings[2]
2. Curriculum-based with proactive energy savings tips for the home[3]
3. Curriculum-based with hands-on activities or projects directed at saving energy
4. Curriculum-based with energy saving kits

In looking across K-12 energy education program offerings outside of Massachusetts, we identified six programs that quantified energy savings, three of which claimed these savings as part of their portfolio. Notably, two of the three that claim savings provide kits to students while the third

[1] In total, the team conducted seven interviews.

[2] Note that some of these programs have outreach events or other activities.

[3] Ibid.

coordinates with the schools to conduct a school-based project that saves energy. The savings for the kit based programs ranged from approximately 300kWh[4] to 500kWh per student.

Among these programs, only one, the California K-12 Energy Education program (CA E3), attempted to quantify savings from behavioral efforts, but savings from these efforts were not claimed. Savings from this program were calculated by asking students about what actions they took in the home after receiving the curriculum. Savings were most often derived from students' installing CFL bulbs, turning off lights when not in a room, and reducing appliance use in the home. Savings ranged from 400 kWh per student (low estimate) to 1,400 kWh per student (high estimate) when both measure installations and behaviors were included.

Literature Review Findings

K-12 Energy Education Programs

While almost all of the programs that the team reviewed took steps to quantify savings attributable to their respective programs, only a small number ultimately claimed energy savings. As shown in Table 1, those programs claiming savings involved either the distribution of take-home kits containing energy savings measures such as CFLs and low flow showerheads, or a hands-on project such as an audit of school facilities that resulted in facility improvements. In general, the programs did not target specific grade levels. However, both the CA E3 and CT Energy Education programs did implement curriculum aimed at particular grade levels. The former served students in grades 1, 4, 6 and 8-10 while the latter served students in grades 9-12.

Table 1. Summary of K-12 Programs Reviewed

Program Category	Programs Reviewed	Number Reviewed	Quantified Savings	Claimed Savings
1. Curriculum based offerings	• CT EE Smarts	1		
2. Curriculum based with tips	• DOE School Energy Programs • CA K-12 Energy Education (E3)	2	2	
3. Curriculum based with hands-on activities or projects	• Kentucky NEED • CT Energy Education • Wisconsin KEEP • CA School Energy Efficiency Program	4	2	1
4. Curriculum based with take-home kits	• Ohio Energy Program • LivingWise	2	2	2
	Total	**9**	**6**	**3**

The programs reviewed as part of this research effort feature a number of unique program design components worth highlighting here. Additional details on each of the programs assessed are available in Appendix A. Design and implementation strategies of note are as follows:

[4] This 300 kWh is from the vendor website, not from a study reviewed for this report.

- Among programs focused exclusively on the dissemination and implementation of energy education curriculum, there is a trend towards distributing CFL bulbs through school fundraising.[5] The Wisconsin KEEP program illustrates how teachers can focus on implementing an energy education curriculum while the school more generally can engage in a complementary activity.

- The Kentucky NEED Program (Category 3) has implemented a unique approach that uses a particular type of student project as a vehicle for both measure installation and data collection to support Measurement and Verification (M&V). As part of this program, students perform a plug load study of vending machines and receive a vending miser. Once installed, the students complete a post-installation study to assess changes in energy use, and the data gathered is used to document energy savings.

While the following section of the memo focuses on programs claiming energy savings, it is important to note that many of the programs track reach and participation as key performance metrics. Others have also attempted to quantify savings, but have not claimed them yet. Please see Appendix A for details related to these efforts.

In Appendix B, we also compare our findings to the Cape Light Compact's current program design.

Claimed Savings

The K-12 energy education program savings claimed by program administrators ranges widely given the limited number of data points available. Generally these savings come from the installation of measures, although one study quantified savings from behaviors (discussed further below). As shown in Table 2, gross electric savings claimed by program administrators ranges from 490 MWh to 5,830 MWh. We also identified one program claiming gas savings. Notably, none of the programs we reviewed quantified or claimed net savings associated with the programs.

Table 2. Range of Savings Claimed by K-12 Energy Education Programs

Program Category	Program	Gross Savings Quantified	Savings Claimed	Estimated Electric Savings (per student)
Tips	CA E3 K-12 Education	53 MWh 18 therms	N	870 kWh 0.3 therms
	DOE School Energy Program	2.5 MWh	N	300 kWh
Activities	CT Energy Education [a]	--	Y	--
	Kentucky NEED [b]	--	N	--
Kits	LivingWise Energy Education	491 MWh 51,847 Therms	Y	452 kWh
	Ohio Energy Project	5,830 MWh	Y	515 kWh

[a] Savings for the CT Energy Education Program are not provided here as the team did not receive supporting documentation for the savings the program said it quantified.

[b] We do not provide savings here as the team did not receive supporting documentation. In addition, savings quantified for this program related to a specific project type and cannot be provided on a per student basis.

[5] This is also an activity that some of the MA PAs have implemented.

Energy Savings Calculations

The following table presents the energy saving measures installed through various programs, as well as the installation and adoption rates associated with those measures.

Table 3. Basis of Savings Quantified by Program

Measures Distributed		Reviewed Programs					
		LivingWise[a]	Ohio Energy Project[b]	DOE SEP	CA E3 K-12	CT Energy Education	Kentucky NEED
Installed measures	CFL bulbs	X (74% install rate)	X		X		
	LED bulbs		X				
	Low flow showerheads	X (39% install rate)			X		
	Faucet aerator	X (47% install rate)					
	Air Filter Tone Alarm	X (23% install rate)					
	LED Nightlight	X (80% install rate)	X				
	Door Sweep		X				
	Thermometer		X				
Behavior	Behavioral Changes	X (24-56% adoption rates)			X		
School-level equipment	Vending Miser						X
	School Facility Audit			X		X	

[a] Installation and adoption rates are based on 61 respondents. Results were not extrapolated to the population as the evaluators used a convenience sample.

[b] The team did not receive the installation rate information requested from OEP.

At its foundation, the assessment of energy savings potential requires knowledge of baseline conditions. For example, program administrators and evaluators need to know what type of equipment a household (or school facility) had in place before participating in the program. They must also know the type of behavior the household exhibited and with what frequency they performed certain actions or behaviors.

Installation rates are an essential input to determining savings when programs distribute energy saving products. As illustrated above, installation rates vary by measure with many of the gas saving measures exhibiting lower installation rates than lighting measures. In order to quantify savings, program administrators must establish mechanisms to determine whether energy saving measures are installed and operating. These mechanisms, such as surveys for students and their parents to complete stating what measures they installed at home are most valid and reliable when they are incorporated into the program implementation requirements. For example, programs may require that teachers administer this survey and report the results back to the program administrators as part of the participation requirements and expectations. Programs often offer an incentive to ensure that teachers receive completed surveys from every student such as a gift card for school supplies.

When a program seeks to encourage changes in behavior, the analysis moves beyond an individual student to the household. This expanded scope makes estimating energy savings potential in this area more difficult than other program options. Further, estimating energy savings from behavioral changes involves determining the adoption rate of specific behaviors, as well as the frequency with which they occur. Among the programs we reviewed, the highest adoption rates were associated with lowering the temperature setting associated with home heating (56%) followed by increasing air conditioning temperature settings (52%), and adjusting the hot water heater temperature all as part of the LivingWise program.

Program administrators must also consider the persistence of behavioral changes when determining how to achieve savings through behavioral program elements. In general, the measure life for behavioral changes is assumed to be one year.

In general, data like installation rates are derived based on information gathered through quantitative surveys with students and/or their families. Students may be given pre- and post- take-home surveys related to actions taken using the energy saving kits, as well as pre- and post- student tests on awareness and knowledge. One program also used an online survey after the take-home kits were distributed to assess installation and changes to the home.

In terms of facility based projects, data is collected through onsite surveys/audits, and participants provide 1-2 years of billing data so that the school can be benchmarked using ENERGY STAR Portfolio Manager. The team requested additional information from CT Energy Education, but did not receive additional detail on savings calculations.

In considering potential methodological approaches for calculating energy savings due to K-12 energy education programs, it is worth noting that billing analysis is generally not used. Not only is this method not always capable of picking up the savings from the measures and/or behavioral changes, but it is also challenging to identify the households in which students live and to access their billing data due to customer and minor confidentiality issues. Therefore, programs often collect data to support energy savings calculations through student and household surveys whether online or in hard-copy. The team provides a number of recommendations with regard to data collection in the Best Practices and Recommendations Section.

Best Practices

Based on our review of the K-12 energy education programs presented in this memo, we highlight the following best practices. These practices will help to enable the quantification of energy savings and the definition of program success.

Program Design

- **Consider adding a more direct energy saving component such as kits or hands-on projects.**

Including these components in the program will enable program administrators to more directly link the program with some energy saving action. While it is possible to determine the energy saving impact of changes in behavior, quantifying the savings associated with specific measures is less expensive and less time consuming. In other areas of the country, NEED does provide kits as part of its program offerings. They also work with program administrators to customize a kit for their service territory.

- **Find a way to provide the students with direct and actionable tips for their home.** As part of the NEED curriculum, students are assigned several take-home tasks including reviewing guides on energy efficiency, conducting home audits, and in some cases, reviewing take-home energy kits, which could contain energy saving measures. The Massachusetts program administrators could develop a specific set of tips based on these curriculum components, and should document and track the tips provided, as well as follow-up to see which have been implemented.

Savings Estimation

- **Use engineering estimates to estimate savings.** As we have seen across a number of programs, it is critical to develop algorithms for tips or measures distributed or promoted through the program based on prior evaluation or secondary data if EM&V results are not available. We recommend leveraging the Massachusetts Technical Reference Manual (TRM) to establish the engineering algorithms and measure savings.

  The following table documents the inputs needed for engineering estimates of savings for measures or tips commonly provided to students participating in K-12 energy education programs. Should the program decide to directly offer tips or kits, we recommend documenting all of the inputs needed for calculating savings in advance and determining what should be gathered from students and parents.

Table 3. Example of Key Inputs for Engineering Estimates of Savings

	Measure/Action Taken	
	Replace incandescent light bulbs with a CFL	Install low flow showerheads
Savings Calculation Inputs	New bulb wattage	Base gallons per minute (gpm)
	Base bulb wattage	New gallons per minute (gpm)
	Hours of Use (HOU)	Number of people per home*
	Waste Heat Factor (WHF)	Number of minutes per shower
	Coincidence Factor	Number of showers per person per day
	In-Service Rate*	Number of showerheads per home

Note: Only the items marked with an asterisk come from students and households.

Data Tracking

- **Document the curriculum and lesson plans provided to participating teachers, as well as the tips or recommendations made to students about how to save energy at home.** In addition, we recommend tracking the following: teacher first and last name, number of students taught by teacher, grade levels taught by teacher, teacher school, teacher district. Program data should also be complied and tracked using an electronic database that is easy to update and use. This will allow for real time tracking of program performance.

Data Collection

- **Build data collection into the curriculum**. By asking students to gather information about their actions or the energy saving items they have installed at home as part of classroom activities it will help ensure better and more accurate response rates. In addition, integrating data collection into the curriculum will eliminate self selection bias and remove the need for any sampling of program participants. Notably, programs often need to incent teachers to administer and receive these surveys from all students.

- **To the extent possible, the program should seek parental engagement in the data collection process**. The involvement of parents in data collection activities will help to ensure the accuracy of the data collected, particularly when information on household behaviors is needed to estimate savings.

- **Consider an online option for the input of student data that includes a reporting function so that program staff has real-time access to program tracking data and can download the results for their own use**. The team identified programs with online survey options where students and their families can log-in to enter information. We also documented program challenges associated with manual data entry.

- **Consider data collection methods that will allow for calculating both gross and net energy savings**. While most programs only calculate gross savings, programs should put mechanisms in place to assess net savings so that the need for the program's intervention in the marketplace can be assessed and tracked over time. One method to derive net savings is to implement pre and post student surveys. This evaluation approach will allow program staff and evaluators to more accurately identify those actions that are attributable to the program as opposed to other factors. Given that the NEED Project curriculum already contains pre and post student surveys (see attached documentation) to assess knowledge gain, program administrators should build upon that foundation or tailor survey efforts to gather additional data regarding actions taken in the home.

Quality Control and Verification

- **Develop an evaluation strategy that includes follow-up with participants to help provide an accurate estimate of measure installation and any other key inputs**. It is important that this research is conducted within a reasonable timeframe following the distribution of tips or kit measures. These data collection efforts may also be used to gather information on satisfaction with the program and changes in behavior.[6]

[6] While we attempted to gather information related to data collection and implementation costs through our interviews, none of the individuals we spoke with could provide it. However, we do provide program implementation costs for the CA E3 and DOE programs in Appendix A.

A. APPENDIX - PROGRAM DESCRIPTIONS

This Appendix presents descriptions of each program for which the team identified an impact evaluation report or was able to gather information directly from program administrators. We also provide process-related information for the K-12 energy education programs where available.

Table 4. Summary of Program Descriptions

Program	Category
CA E3 K-12 Energy Efficiency Education	Curriculum based with tips
DOE School Education Program	Curriculum based with tips
Kentucky NEED	Curriculum based with hands-on activities or projects
CT Energy Education	Curriculum based with hands-on activities or projects
Wisconsin KEEP	Curriculum based with hands-on activities or projects
Ohio Energy Project	Curriculum based with take-home kits
LivingWise	Curriculum based with take-home kits

CA E3 K-12 Energy Efficiency Education

The California K-12 Energy Efficiency Education (E3) program targets students in grades 1, 4, 6, and 8-10. The program's over-arching goal is to teach students and their families about the benefits of conserving energy and how their actions can "Save Energy, Save Money, and Save the Planet."

The E3 program was implemented in the San Diego Gas & Electric utility territory in the 2006-2008 program cycle.[7] The program sought to reach all students in targeted grades within the San Diego Unified School District. The E3 program quantified the energy savings generated from self-reported actions taken in the home by students. However, E3 is not able to claim these savings.

Program Name	Quantified Savings	Claimed Savings	Evaluated	Reports Available
California K-12 Energy Efficiency Education	Y	N	Y	Y

Program Description

E3's program is best categorized as one that is **curriculum based with tips.** The program began developing curricular materials during the 2006-2008 program cycle, and was only able to begin implementation of the materials in grades 1, 4, and 6 during that time period. The educational materials provided and targeted at the school district level included a lesson plan to supplement the regular science curriculum with energy resource and energy efficiency topics and lab activities. Each lesson also described specific behaviors and actions that students and their families could take to save energy at home. Teachers were also offered a training workshop to supplement the lesson plan, in which 243 teachers participated.

As a result, the E3 program reached 12,116 students, only about 3% of the target population. The program's reach was lower than expected given delays in launching the program, as well as in developing the curriculum. Of these 12,116 students, 4,023 were in fourth grade (the first grade to receive the curriculum), 3,248 were in sixth grade, 1,895 were in kindergarten and first grade, 1,677 were in high school, and 1,273 were in other grades.

Evaluation Design

To assess the impact on knowledge and awareness of energy issues, the evaluator conducted in-depth interviews with teachers, as well as classroom observations. Two post-curriculum surveys were also fielded, one to teachers and the other to students.

Savings was calculated based on the actions reported in the student post-curriculum survey, which received 61 responses. It is important to note that the program did not track how many students received the survey, but the evaluation team estimated that it was between 200 and 300 students. The evaluator then calculated high, medium, and low gross savings estimates, based on extrapolations to different proportions of the total participant population.

The evaluation found that most students (87%) reported making changes to save energy in their home due to the program. The most frequent actions reported that were used in estimating energy

[7] While the team does not have official confirmation of its cancellation, this program is no longer included in the program portfolio.

savings included replacing incandescent lights with Compact Fluorescent Lamps (CFLs) (312 bulbs installed), turning off lights when out of the room (53 households reporting), reducing use of appliances (48 households reporting), turning off or unplugging small appliances (4 households reporting), purchasing an ENERGY STAR® washing machine (1 household reporting), and installing low-flow showerheads (1 household reporting). Based on these actions, the middle estimate of total program savings was 53 MWh and 18 therms.

Table 5. Evaluation Overview

Data Collection Method	• In-depth interviews with teachers • Classroom observations • Take-home student survey • Post-curriculum teacher survey
Indicators of Success	• MWh and therm savings • Percentage of students who made EE changes at home
Energy Savings Calculation	• Energy savings are calculated based on estimates of measure installation and behavior change. High, Middle, and Low estimates of MWh savings were given for each behavioral change
Energy Savings	• Total program savings of 53 MWh and 18 therms (middle) • 87% of students made EE changes at home

Best Practices

Our review of E3 did not reveal any best practices for program implementation for a curriculum only program.

U.S. Department of Energy School Education Program

The School Education Program (SEP) was one component of the State Energy Program, which is funded by the U.S. Department of Energy (DOE). The program used curricular materials to teach K-12 students about energy efficiency topics, through materials either developed or provided by the program.

Energy savings from this program was driven by actions taken at home by students involved in the program. While the DOE was able to quantify estimated energy savings from the program, because this program is not administered by a utility, the program administrators did not claim these savings.

Program Name	Quantified Savings	Claimed Savings	Evaluated	Reports Available
DOE School Education Program	Y	N/A	Y	Y

Program Description

SEP is best categorized as a program that is **curriculum based with tips.** The program offered curriculum to teachers in the hopes that energy education in the classroom would translate into measurable actions in the household. The theory behind the program's design is that if students can influence their household, energy savings will result from a set of program-specified actions. As of 2002, the program had reached 604,050 students across 34 states.

In particular, participating teachers asked students to take energy saving actions at home, such as resetting the water heater thermostat, installing low-flow showerheads, installing pipe insulation, and installing CFLs.

Evaluation Design

To quantify energy savings per student and program-wide, an Oak Ridge National Laboratory research team first estimated the percentage of students likely to influence their families to take action at home. The evaluator then used data on average savings generated by each recommended action to estimate the energy savings generated by the program. An evaluation of additional environmental benefits, such as reduction of carbon dioxide and other greenhouse gases, was also conducted.

In particular, evaluators assumed that 12.5% of all participating students took energy-saving actions at home. They based this assumption on a study from an Ontario elementary school recycling education program. Through a survey of parents who had children in participating classrooms, the Ontario program found that 25% of families made significant changes in their recycling behavior as a result of the program. To account for differences in program design and specifically the fact that parents were actively involved in the Ontario program, the SEP evaluators divided the 25% in half to arrive at a conservative estimate of student influence on household actions.

The evaluator then determined the average annual savings associated with four specific actions: resetting water heater thermostats, installing CFLs and low-flow showerheads, and insulating hot water pipes. Furthermore, the evaluator assumed that all the students took all of these actions at home. Based on these assumptions, the evaluation estimates that the average annual energy savings associated with these actions is 8.6 million source BTUs per student if all students took these saving actions home, and multiplying by the 12.5% who did take actions home, the evaluators estimated 1.1 million source BTUs of savings per student.

Based on the savings estimates above, the evaluation estimated that the School Education Program saved 660,000 source MBTUs, about 1.4% of all State Energy Program savings. The evaluation also found that the program resulted in about 10,400 metric tons in carbon reductions.

Table 6. DOE Evaluation Overview

Data Collection Method	• Review of secondary data on measure level savings and student influence in the home.
Indicators of Success	• Source BTUs savings per student and across the program overall • Metric tons of carbon reduced • K-12 students reached by the program
Energy Savings Calculation	• Energy savings are calculated based on a review of secondary data sources for measure level savings (CFLs, showerheads, pipewrap, adjusting water heater temperature), and student influence.
Energy Savings	• 1.1m source BTUs per student • 660,000 MBTUs saved across program • 10,400 metric tons carbon reduced

Energy Savings Calculation (Detailed)

Savings for participating students was based on the assumed proportion of students influencing their families to take energy saving actions, and the average annual savings associated with all four designated actions. This formula is provided below:

$$Average\ Annual\ Savings = 0.125\ (proportion\ of\ students\ influencing\ their\ families) \times 8.6\ million\ BTU\ (average\ savings\ from\ home\ actions)$$

Best Practices

Our review of SEP identified the following best practices in program implementation:

- Encouraging a strictly defined set of household actions can help to quantify energy savings by controlling variation and concentrating evaluation resources.

Kentucky NEED

Targeting K-12 teachers and students, Kentucky NEED provides classroom resources and training on energy for teachers and opportunities for students to apply what they have learned through studies of energy use and management in their school.

While Kentucky NEED does not claim savings, it has quantified savings from its VendingMiser initiative in particular. Estimated savings is calculated based on student-led plug-load studies that gather pre- and post-installation kW consumption from a vending machine in the school. Based on our interviews with staff involved in the Kentucky program, the program administrators were hesitant to claim savings given that their program was not fully independent from the national NEED organization.

Program Name	Quantified Savings	Claimed Savings	Evaluated	Reports Available
Kentucky NEED	Y	N	N	N

Program Description

The Kentucky NEED program is best categorized as one that is **curriculum based with hands-on activities or projects.** The program not only provides teachers with the means to educate themselves and teach students about energy, but also gives students the opportunity to apply what they have learned by actively helping to reduce the school's energy use.

Teachers are given access to NEED Project curriculum materials and workshops, which have been customized by the Kentucky branch based on the specific interests of the sponsoring utilities. Kentucky especially targets teachers who are already teaching students about energy, such as science teachers.

Once students have been introduced to the concepts of energy efficiency, they are encouraged to form Student Energy Teams. These teams work with the faculty and school administration, as well as analyze the school facility itself, to determine areas for potential improvement. Students provide staff with energy savings tips, such as turning off lights in unused rooms, and engage directly in energy efficient actions such as removing phantom plug loads before weekends and holidays.

Evaluation Design

Currently, Kentucky NEED has only quantified savings for the VendingMiser project and does not claim the savings. While this initiative is not formally evaluated, verification is performed by the Student Energy Teams. Students first conduct a two-week plug-load study of a vending machine and submit the findings to Kentucky NEED. The school is then sent a VendingMiser (a piece of equipment that regulates the energy use of vending machines). After installation, a second, two-week study is conducted and the results are provided to Kentucky NEED.

As noted above, energy savings is calculated by Kentucky NEED based on the difference in the vending machine's kW consumption pre- and post-installation of the VendingMiser. As a result of this program, Kentucky NEED has found a statewide average of 47% savings on vending machine kW.

Table 7. Kentucky NEED Evaluation Overview

Data Collection Method	• Pre and post Vending Miser installation plug-load study before and after installation
Indicators of Success	• kW savings
Energy Savings Calculation	• Energy savings are calculated based on pre and post vending machine kW consumption
Energy Savings	• Statewide average of 47% savings

Energy Savings Calculation (Detailed)

Savings associated with Vending Miser installation were based on kW usage documented by students.

$$VendingMiser\ Savings = kW\ consumption\ before\ installation - kW\ consumption\ after\ installation$$

Students are also asked to calculate the potential savings for the school and school district at two-week and full-year increments.

Best Practices

Our review of Kentucky NEED did not reveal any best practices for program implementation for a curriculum only program.

CT Energy Education

CT Energy Education is implemented by the Institute for Sustainable Energy (ISE) at Eastern Connecticut State University (ECSU). The primary goal of the program is to equip teachers with resources for teaching students in grades 9-12 about the fundamentals of energy, energy efficiency, climate change, and greening schools. ISE reinforces messaging around green schools by offering energy audits of school facilities.

The goal of CT Energy Education is to spread awareness and knowledge, and the program has not attempted to quantify energy savings associated with its classroom curriculum. However, the program administrator has quantified the savings generated by the school audits in the past and they are currently updating their evaluation report.

Program Name	Quantified Savings	Claimed Savings	Evaluated	Reports Available
CT Energy Education	Y	Y	Y	N

Program Description

The CT Energy Education program is best categorized as one that is **curriculum based with hands-on activities or projects.** CT Energy Education is staffed by education professionals who develop lesson plans, write curriculum, and offer a workshop for 9-12 grade teachers. The curriculum is primarily concerned with increasing students' awareness of energy issues and includes lessons in five areas: energy fundamentals, climate change, energy efficiency, green jobs, and green schools. Teacher participation in the program is monitored via an online system that tracks downloads of teaching resources from a centralized website (http://www.ctenergyeducation.com/).

CT Energy Education also prioritizes the promotion of green schools. CT Energy Education not only offers formal benchmarking audits, but has also developed lesson plans that empower students and teachers to audit their own classrooms and facilities.

Evaluation Design

CT Energy Education has quantified the energy savings from school energy audits and currently claims these savings. The program has audited 30 schools over five years and is currently in the middle of an evaluation cycle.

To apply for a formal benchmarking audit, schools first submit one to two years of energy bills. CT Energy Education then inputs this information into ENERGY STAR® Portfolio Manager, which benchmarks the school compared to similar buildings according to national energy efficiency standards. A site visit is also conducted in which the audit team identifies areas for potential improvement. The end-result is a report delivered to the school that provides graphical and written analyses of the facility's energy use and suggests improvements.

CT Energy Education also provides lesson plans for student-led audits. Teachers can download a class presentation and audit checklist from the program website. Students use these materials to evaluate several aspects of the classroom, including plug loads, lighting and heating, and air conditioning. After conducting the audit, students and teachers then meet and discuss their findings and how the classroom can be improved.

Table 8. CT Energy Education Evaluation Overview

Data Collection Method	• Review of billing data • School facility audit
Indicators of Success	• Reduction in facility energy use • Compliance with ENERGY STAR standards
Energy Savings Calculation	• Requested this information from the program administrator, but have not received it
Energy Savings	• Requested this information from the program administrator, but have not received it

Best Practices

Our review of CT Energy Education identified the following best practices in program implementation:

- Employ education professionals who have expertise in curriculum writing and the development of lesson plans.
- Track teacher participation in the program by monitoring downloads of learning resources.

Wisconsin KEEP

In its 17th program year, the philosophy of the Wisconsin K-12 Energy Education Program (WI KEEP) is that by focusing solely on empowering teachers to teach about energy efficiency and energy related issues, the program can more effectively increase student knowledge and awareness than if the program worked directly with students. As a result of this focus, KEEP offers professional development programs to teachers, as well as assists them in building curriculum. KEEP also encourages teachers and students to use the school facility as an example of how to conserve energy by offering special lesson plans and, in the past, school energy audits.

WI KEEP has not quantified energy savings, but considers the number of teachers and students reached by the program as the primary metric of success.

Program Name	Quantified Savings	Claimed Savings	Evaluated	Reports Available
Wisconsin KEEP	N	N	N	N

Program Description

The KEEP program is best categorized as one that is **curriculum based with hands-on activities or projects.** The program specifically targets technology education teachers and encourages them to incorporate energy efficiency into their lessons.

Linked with one of Wisconsin's state universities, KEEP offers teachers seven graduate-level courses, for which they can receive course credit. These courses are offered both in-person, as well as online. KEEP also assists teachers in developing lesson plans through classroom activity guides, which teachers of any K-12 grade can incorporate into their curriculum. Topics included in these activity guides include "what is energy?" and "how do I manage it?" For teachers in schools with limited resources, KEEP also provides School Energy Education Guides, special tools that show teachers how they can use the school itself as a cost-effective, on-site example of making energy efficient improvements. To further promote the greening of schools, KEEP has also conducted energy audits which help schools develop action plans to involve the entire faculty, administration, and student body in conserving energy.

Over the lifetime of the program, KEEP estimates that it has reached 2.8 million students. KEEP assumes that each teacher reaches 60 students per year, based on average class sizes and the number of classes taught. Over 16 years, the program has trained or assisted 5,400 teachers And KEEP assumes that teachers retain this knowledge and continue to teach it, which translates into 324,000 students reached just in the current year.

Best Practices

Our review of WI KEEP identified the following best practices in program implementation:

- Offering graduate course credit is a good incentive for getting teachers to buy into the program.
- Using the school as an on-site example of how to improve efficiency is a cost-effective solution for schools with limited funding or resources.

Ohio Energy Project

Formerly known as Ohio NEED, the Ohio Energy Project (OEP) targets K-12 teachers and students with the goal of empowering the next generation with knowledge and awareness of energy issues and how they can conserve energy. OEP accomplishes this goal by providing NEED curriculum to teachers, and offering field trips and take-home energy efficiency kits to students.

Energy savings are primarily derived from the take-home energy kits provided to students. The program assesses the equipment installed from the kit, as well as self-reported changes in behavior based on the curriculum. The program estimates installation rates associated with the kit items through an online survey completed by the parents and students who receive the kits. OEP currently claims energy savings with one of the sponsoring utilities, American Electric Power, from the take-home kit portion of its program.

Program Name	Quantified Savings	Claimed Savings	Evaluated	Reports Available
Ohio Energy Project	Y	Y	Y	N

Program Description

The Ohio Energy Project is best categorized as a program that is **curriculum based with take-home kits.** OEP supplies teachers with resources to teach students about energy efficiency, as well as gives students the opportunity to apply what they have learned by improving the energy efficiency of their household through equipment provided in the take-home kit and self-reported changes in behavior. Having equipped students with the knowledge and potential to become future energy experts, OEP also organizes field trips that give students the opportunity to learn about education and career opportunities in the energy field.

OEP not only provides K-12 teachers with lesson plans, in-class activities, and curriculum on energy education, but also encourages the students to become the teachers. OEP trains and supports high school students to pass on their knowledge of energy efficiency to elementary school students. In its fourth project year, approximately 401 teachers in 259 schools have participated in the program.

In addition to the classroom experience, students are given take-home energy efficiency kits, which include energy efficient equipment such as LED light bulbs, an LED nightlight, and door sweeps. The program administrator developed the kits with NEED and customized them based on the specific needs and interests of the funding utilities. However, information on the cost of the kits and the measures included in them was not available.

Through a close relationship with the University of Ohio and Ohio State University, OEP takes students on field trips to learn more about education and career opportunities in energy efficiency. Students are also periodically taken on site visits to locations such as private mining operations.

Evaluation Design

OEP currently quantifies the energy savings gained from the take-home kits. The data needed for this assessment is gathered through online surveys completed by parents and students after they receive the kit. The survey asks students to report on the measures they and their parents installed from the kit and energy saving behavioral changes they made. Hard-copy versions of the survey and computer lab access were made available to students without a computer at home. Survey responses are used to determine installation rates, as well as changes in energy efficiency knowledge and awareness that result from the program. Those who did not complete a survey were

calculated as having a 0% installation rate.

The program administrator also tracks participation through the completed surveys. Currently, participation is tracked manually (results are recorded manually then inputted into another database), which is error-prone.

In 2011, OEP distributed a total of 12,944 kits. They received 11,315 surveys (an 87% response rate) and have estimated 5,830 MWh savings.[8]

Table 9. Ohio Energy Project Evaluation Overview

Data Collection Method	• Post-kit delivery online student survey
Indicators of Success	• MWh saved • Installation rate of measures in the kit • Self-reported behavior changes
Energy Savings Calculation	• Based on survey responses related to installation of kit equipment • Non-responses counted at 0% installation
Energy Savings	• 5,830 MWh savings

Best Practices

Our review of the OEP identified the following best practices in program implementation:

- If an Internet-based survey is used to assess measures installation, the program administrator should make sure to include alternative options for completion to account for students without computing resources at home (computer labs and hard-copies).
- An electronic participant tracking system is less likely to result in tracking errors than a hand-written tracking system.

[8] While a presentation prepared by the evaluator of this program speculates that the high response rate is due in part to the fact that this program is more extensive than other school programs, we could not find any documented explanation for this high rate.

LivingWise

The LivingWise program is an energy efficiency education program that primarily targets sixth-grade students. Implemented by Resource Action, the program has three over-arching goals: (1) Increase knowledge and awareness of energy production and use; (2) Promote adoption of resource-saving actions; and (3) Familiarize students with the contents of the energy saving kit and encourage the installation of those measures in students' homes.

Quantifiable energy savings from this program was derived from the energy efficiency equipment provided in the take-home kits as well as self-reported changes in behaviors. LivingWise has claimed these savings with the utility.

The Cadmus Group led the evaluation of the take-home kits for the 2006-2007 cycle, with Opinion Dynamics Corporation serving as a subcontractor. The program is implemented in several states, but in this particular evaluation was implemented in Aquila and Alliant Energy territories in Iowa. Reports have been made available on CALMAC.

Program Name	Quantified Savings	Claimed Savings	Evaluated	Reports Available
LivingWise	Y	Y	Y	Y

Program Description

The LivingWise program is best categorized as one that is **curriculum based with take-home kits.** Through this program, students are not only given increased access to energy education within the classroom but also the opportunity to apply what they have learned in the household. Thus, LivingWise considers indicators of success to be increases in knowledge and awareness as well as energy saved (electricity, water, and gas).

The educational materials comprise a four-week lesson plan that includes information on energy resources and energy savings actions. The evaluation estimated that the LivingWise program reaches about 1,100 students per year, with participating school districts teaching the program each year to their sixth graders.

The kits include both items that provide direct energy savings and items that provide the ability to measure usage of existing equipment. Direct install measures included in the kit were CFLs, an LED nightlight, a faucet aerator, an efficient showerhead, and a filter tone alarm. Measurement devices included, for example, flow-rate bags.

To gauge knowledge and awareness gained from the program, students took pre- and post-tests on energy efficiency. The number of correct answers in the post-test increased by 9% as a result of the take-home kits.

Evaluation Design

A total of 1,083 students completed two take-home surveys on actions, taken before and after receiving the kits. Students self-reported which kit items were installed and changes in household behaviors to promote energy efficiency.

Energy savings was calculated primarily based on the installation rate of items from the kits. However, evaluators also added savings from adjusting water heating temperature (electric and gas) and air conditioning, based on the adoption rates of these behaviors reported in the survey.

For the major metrics, the evaluation found that annual energy and water savings as a result of the program was 490,164 kWh, 51,847 therms, and 6,030,933 gallons of water. Installation rates ranged from 23% to 80% and adoption rates from 24% to 56%.

The evaluation also conducted a cost-effectiveness analysis. Annual estimated (not lifetime) home energy bill savings is $84 per participant (aggregate, not divided into electricity/gas), and program participant cost is a one-time cost of $54 per participating household.

Table 10. LivingWise Evaluation Overview

Data Collection Method	• Pre- and post-surveys • Pre- and post-tests
Indicators of Success	• Installation rates of kit items • Adoption rates of EE behaviors • Energy and water savings (kWh, therms, and gallons of water) • Increases in EE knowledge
Energy Savings Calculation	Savings derived from: • Installation rates: 80% Nightlight, 74% CFL, 47% Faucet Aerator, 39% Showerhead, 23% Filter Tone Alarm • Adoption rates: 56% lowered heating temp setting, 52% raised AC temp setting, 24% reduced hot water heater temp.
Energy Savings	• 490,164 kWh, 51,847 therms, and 6,030,933 gallons of water

Energy Savings Calculation (Detailed)

Savings for an average participant and the overall program were based on measure installation reported by students that returned surveys. Non-responding participant savings were estimated at an installation rate equal to one-half that of respondents. Savings per participant formulae for each installation measure are summarized below:

CFLs kWh savings per participant =

$$\frac{\textit{Installation rate} * \textit{Average hours/ day} * * \textit{Wattage replaced} - \textit{Wattage CFL}}{1{,}000}$$

$$\frac{Installation\ rate * (Average\ Hours\ Per\ Day * 365\ days) * (Wattage\ Replace - Wattage\ CFL)}{1000}$$

Showerhead annual water savings per participant (flow rate) = *Average reported pre water flow (GPM) – average reported post water flow (GPM) * No. showers/ week * minutes per shower * weeks*

Showerhead kWh savings per participant =

$$Installation\ rate * percent\ with\ electric\ heat * Annual\ water\ savings\ per\ participant\ (gallons) * \frac{8.33\ lbs/gallon}{3{,}414 * water\ heater\ efficiency\ (.9)}$$

Showerhead thermo savings per participant =

$$Installation\ rate * percent\ with\ electric\ heat * Annual\ water\ savings\ per\ participant\ (gallons) * \frac{8.33\frac{lbs}{gallon} * 45°F\Delta T2}{100{,}000 * water\ heater\ efficiency\ (.6}$$

Faucet Aerator savings = Based on the average minutes of use per day and the reduction in flow rate. It also considered the installation rate and the proportion of customers with natural gas and electric water heating.

Filter tone alarm = The alarm creates savings when it alerts a resident to change the filter. The program estimates savings resulting from more regular filter replacement to be 2% of the base energy consumption for heating (average thermo usage for heating the home in the Iowa climate zone was obtained from the Energy Information Administration).

Nightlight =

$$\frac{(Installation\ rate * percent\ replacing\ existing\ lights) * (8hrs\ per\ day * 365\ days) * (7w - .03W)}{1{,}000}$$

Behavior Modifications were measured by the percent of participants making the adjustment (installation rate) and the average adjustment (e.g., 10-degree adjustment). This was calculated for water heating temperature (electric and gas), heating temperature (electric and gas), and cooling temperature (electric) adjustments. It was also informed by The U.S. Department of Energy, Energy Efficiency and Renewable Energy division's estimate of a 3% in energy savings results for every 1-degree reduction in heating temperature.

Impact on knowledge and awareness was measured by the average number of correct answers in the pre- and post-tests.

Satisfaction with the program was self-reported by the students in the post-survey.

Best Practices

Our review of the LivingWise identified the following best practices in program implementation:

- Administering surveys both before and after kits or other programs are delivered improves the ability of evaluations to identify more precisely the savings generated directly from the program (as opposed to factors outside the program).
- Administering tests on energy efficiency and monitoring test scores may be a good way to gauge increases in metrics of success that are difficult to quantify on their own.

B. APPENDIX – CLC SPECIFIC FINDINGS

Below we outline the K-12 energy education efforts currently underway within the Cape Light Compact (CLC) service territory in the context of our findings.

As mentioned in the body of this memo, in general, there are few programs that quantify energy savings and those that do, tend to give students take-home energy saving measures such as CFLs or make energy saving improvements to school buildings such as lighting controls that have quantifiable energy savings.

Currently the CLC program, which utilizes resources available through the National Energy Education Development (NEED) Project, is designed as a curriculum-based program that offers classroom presentations, teacher trainings, energy carnivals and support for energy clubs. As currently designed, there are no efforts that would directly lead to energy savings. The theory is that educating students will lead them to adopt energy saving actions and behaviors.

Based on our review, current K-12 programs can fall into four categories:

1. Curriculum-based offerings[9]
2. Curriculum-based with proactive energy savings tips for the home[10]
3. Curriculum-based with hands-on activities or projects directed at saving energy
4. Curriculum-based with energy saving kits

Based on our review of the current program, CLC's efforts appear to align most closely with the first category, a curriculum-based offering without proactive energy savings tips for the home, hands-on activities directed at saving energy or energy saving kits.

As stated earlier, in looking across other K-12 energy education program offerings, we identified six programs that quantified energy savings, three of which claimed these savings as part of their portfolio. Notably, two of the three that claim savings provide kits to students while the third coordinates with the schools to conduct a school-based project that saves energy. The savings for the kit based programs ranged from 300kWh to 500kWh per student.

The program quantifying savings that is most similar to the current CLC program is the CA E3 K-12 Energy Education Program. Savings from this program are calculated by asking students about what actions they took in the home after receiving the curriculum. Savings were most often derived from students' installing CFL bulbs, turning off lights when not in a room, and reducing appliance use in the home. Savings ranged from 400 kWh per student (low estimate) to 1,400 kWh per student (high estimate). While the curriculum of other programs is comparable to the CLC program, these programs typically have a take-home kit offering and savings are determined by calculating an installation rate for kit measures.

Below we present the data from Table 3 (presented earlier) relative to the CLC program (shown in the final column).

Table 3b. Basis of Savings Quantified by Program

[9] Note that some of these programs have outreach events or other activities.

[10] Ibid.

Measures Distributed		Reviewed Programs						Relevant to CLC Program
		LivingWise[a]	Ohio Energy Project[b]	DOE SEP	CA E3 K-12	CT Energy Education	Kentucky NEED	
Installed measures	CFL bulbs	X (74% install rate)	X		X			X
	LED bulbs		X					
	Low flow showerheads	X (39% install rate)			X			
	Faucet aerator	X (47% install rate)						
	Air Filter Tone Alarm	X (23% install rate)						
	LED Nightlight	X (80% install rate)	X					
	Door Sweep		X					
	Thermometer		X					
Behavior	Behavioral Changes	X (24-56% adoption rates)			X			X
School-level equipment	Vending Miser						X	
	School Facility Audit			X		X		

[a] Installation and adoption rates are based on 61 respondents. Results were not extrapolated to the population as the evaluators used a convenience sample.

[b] The team did not receive the installation rate information requested from OEP.

Additional detail on the Cape Light Compact K-12 program is provided below.

Background on the Cape Light Compact K-12 Program

CLC administers an energy education program within its service area with the goal of creating an energy literate society. The program seeks to achieve this goal through an energy related curriculum, as well as activities and events outside of the classroom. These program components are geared towards students in the fifth through twelfth grades and consist of the following:

- Lesson plans and curriculum dealing with topics such as energy sources, electricity, and conservation.

- Classroom presentations by CLC staff or program affiliated teachers involving demonstrations or the use of metering equipment to provide hands-on experience.

- Teacher seminars and training sessions in critical curriculum areas. These sessions help to recruit new teachers and maintain the network of teachers already in place.

- Energy carnivals showcasing energy efficiency tools and technology. These events allow older students to teacher younger ones. They also often culminate with a CFL fundraiser.

- Support for energy clubs in the form of ongoing program staff guidance throughout the year and submission of club scrapbooks to the National Energy Education Development (NEED) Project for recognition of club activities.

The majority of the educational materials provided to teachers by CLC come from the NEED Project, a national energy efficiency education program that provides free lesson plans to K-12 teachers. NEED lessons are offered as supplemental, one-lesson workbooks that teach students about specific energy resource and energy conservation topics. As part of the CLC program, CLC staff work with local teachers to identify the best educational resources available and provide them directly to teaching staff as opposed to directing them to the NEED Project website where materials are also available for download. In addition to NEED, CLC staff may provide educational resources from the National Science Teachers Association (NSTA), National Energy Foundation (NEF), and the KidWind Project.

In general, CLC provides materials and teacher assistance in five areas that are consistent with the NEED Project curriculum: the Science of Energy, Renewable and Nonrenewable Sources of Energy, Electricity, Transportation, Efficiency and Conservation. Educating students in these areas is intended to raise their awareness and encourage them to take energy saving action in the future. However, while the program is tracking the number of teachers and students reached, the program is not currently tracking the materials provided or the content covered in participating classes. This could be problematic for the program because it will be challenging to determine whether curriculum is effective in reaching program goals if the exact curriculum students receive is unknown. Education programs should be able to connect the curriculum students receive to the intended outcomes. For example, a program cannot expect a student to go home and take specific energy saving actions if those actions were not covered in the curriculum.