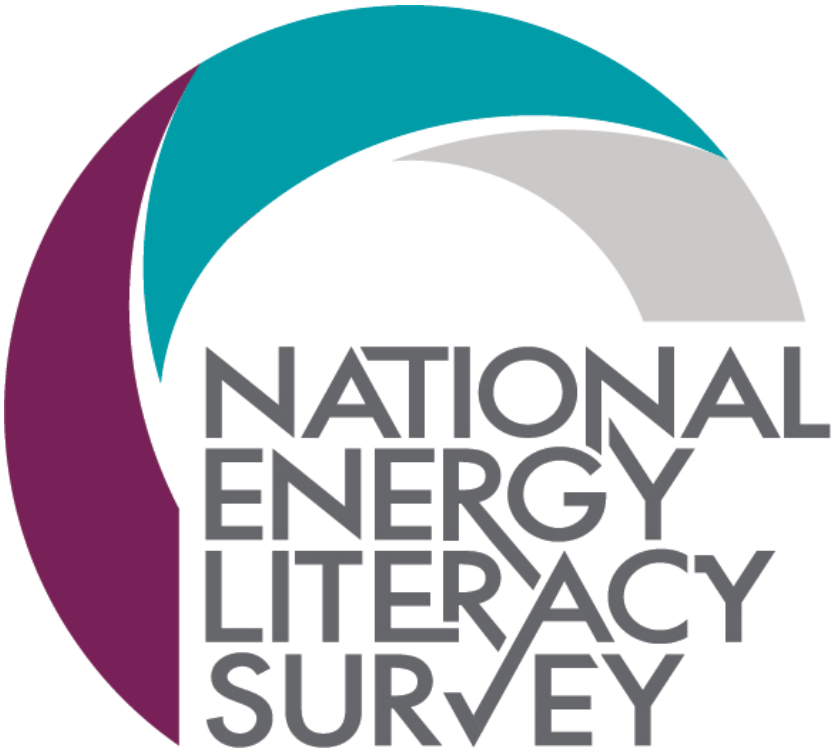

National Energy Literacy Among High School Seniors and Recent Graduates

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Abstract

A national energy literacy survey was commissioned to evaluate the knowledge of high school students pertaining to energy concepts. The information is to be used as a guide for providing students with a sound understanding of energy principles to make informed decisions about energy policies and their energy consumption. To this end, the National Energy Foundation (NEF) developed a robust energy literacy assessment for high school seniors and recent graduates using a sound methodology. The assessment captured responses from a demographically-diverse population of 2,005 high school seniors and recent graduates with the aim of evaluating energy literacy. The survey assessed energy literacy by measuring understanding of five core energy topics. The intent of this study was to accomplish two items: (1) develop a framework for measuring energy literacy and (2) obtain a benchmark. With this information, educators, industry and governmental organizations, and other interested parties can channel their efforts to increase energy literacy among the leaders of tomorrow. Results of the survey show a low level of energy literacy in the surveyed population, especially on the topic of energy use. Many high school students show an interest in energy topics, but do not generally know how to get involved in energy learning and conservation efforts in a useful way. The findings suggest some possible ways to help students and their families become more well-informed energy consumers.

Energy: A Hot Topic

No matter your personal political affiliation, energy is a hot topic around the world right now. Take for instance the recent press surrounding the Paris Climate Accord, officially known as the "Paris Agreement." Whether you favor or oppose the Paris Agreement, this one topic shows that energy is a driving force in global politics—and it represents only a single point in an ongoing, worldwide discussion. The way leaders and citizens around the globe view energy issues has an ongoing impact on the policies that are passed, upheld, and rejected. Because we are all energy consumers, our understanding of energy-related issues informs our decisions about energy sources, costs, tradeoffs, uses, and opinions on key policy.

This is true at the national level as well. An oft-debated issue in the United States since the 1970s has been the concept of energy security and independence. This energy issue has experienced a dramatic transformation, as revolutionary technological developments in domestic oil and natural gas production have radically altered the discussion. In such a dynamic landscape, an understanding of core energy fundamentals by both leaders and citizens is key to the creation of wise policies that balance energy security with environmental concerns.

At the state and local community level, energy is absolutely at the heart of discussion. State policies promoting energy efficiency and renewable energy, for example, have been enacted in a majority of states over the past few decades and differ significantly from state-to-state. Meanwhile, grassroots initiatives regarding the protection or development of energy resource-rich local lands continually spring up as communities weigh relative economic benefits and environmental impacts. A well-informed populous will certainly lead to better state and local policy results as these and other

energy-related issues that affect local communities are debated in the public square.

Energy Literacy

A popular term for energy savviness is "energy literacy," which the US Department of Energy defines as "an understanding of the nature and role of energy in the world and daily lives accompanied by the ability to apply this understanding to answer questions and solve problems."[1] Energy literacy extends beyond simple scientific knowledge. It includes both a clear understanding of energy systems and an ability and willingness to use that knowledge.[2]

As energy topics and conversations in America and abroad drive opinions, the voters of the future will have a say in important national energy policies. What do these future voters think about energy issues? What have they been taught about consumption? How will they balance the economic and environmental impacts of energy production and use?

These questions and related issues will only gain greater relevance in the coming years. If we want to predict the energy policy and consumption trends of the future, we must measure the energy literacy of today.

How Informed are Americans?

To understand the voters of the future, we wanted to learn more about American high school seniors and recent graduates of today. This is a pivotal age when students transition into young adulthood and take on greater responsibility for their energy consumption, policy votes, activism, etc. This age is so important that the National Energy Foundation (NEF) regularly secures and deploys resources to engage with students early on in their K-12 education. Their goal is that through education, they can help students become more savvy consumers and informed influences on energy policy in the United States.

Various studies and reports[3,4] suggest that American high school students currently have a limited understanding of energy-related topics and issues. The National Energy Foundation (NEF) saw the need for a benchmark assessment that would measure literacy across a broad spectrum of energy-related topics.

Many studies have been launched in an attempt to quantify the nation's energy literacy,[5] generally finding that literacy is low among most Americans. Unfortunately, these studies have often relied on insufficiently diverse sample sizes (both geographically and demographically). Further, most have failed to offer well-rounded frameworks for analyzing energy literacy across multiple topics, or suggest ways to increase energy knowledge.

NEF, in partnership with Cicero, decided to build a framework that would tap a broad, diverse sampling of high school seniors and recent graduates to learn their views on energy. We researched and created a framework for analyzing results across many topics, and we describe that here in this paper. Given NEF's focus on primary and secondary education, this robust study was designed to provide actionable insights for educating students about energy policy and personal consumption.

Research Objectives

In order to develop a clear picture of energy literacy among high school seniors and those recently graduated from high school, we defined four unique research objectives:

- Create a national and regional understanding of energy literacy among young people, and develop data and collateral that can be used to establish a foundation for subsequent efforts to track, understand, and effectively address energy literacy throughout the country
- Test the explanatory and predictive value of various factors typically associated with energy literacy
- Identify perceptions of, and behavior regarding, the core elements of energy literacy

- Assess differences in energy literacy associated with variation in regional, educational, and other demographic categories

Surveying high school seniors and recent graduates allowed us to evaluate the K-12 experience to determine what students have learned as they transition into higher education and the workforce. As tomorrow's voters and energy customers, young people must be well informed, and NEF is committed to supporting this education.

Methodology

To design an effective survey around these key objectives, we leveraged several sources for framework development and stakeholder input. The holistic framework helped to ensure the data captured would provide intelligent and actionable results.

Constructing the Framework: Five Core Concepts

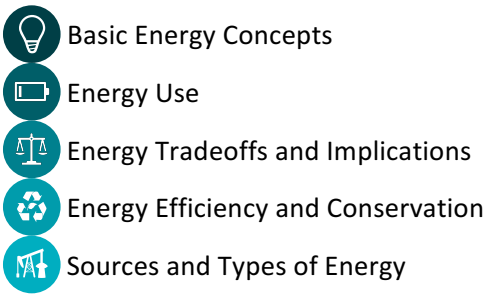
We implemented a holistic research methodology to ensure that the data captured were accurate, complete, and reliable. To identify and measure a relatively abstract concept like energy literacy among high school seniors and recent graduates, substantial time was invested in the development of a framework.

Our first step in developing the framework was to tap into and leverage industry experts. We met with stakeholders across the energy industry to 1) identify core components of energy literacy, and 2) create relevant questions that would help assess those core components. These stakeholders included, but were not limited to:

- National Regulatory Research Institute
- United States Energy Association
- K-12 Educators

In these meetings, we catalogued several insights—from basic notions about energy use and efficiency, to deeper ideas regarding tradeoffs and implications.

These stakeholder insights informed our framework of five core energy topics:



Following the development of the core topics, an inductive approach was taken to refine and define key themes within each category. Working with stakeholders and industry experts, a comprehensive list of concepts, ideas, and facts were identified for each topics (see Table 1 below).

Core Energy Topic	Themes
Basic Energy Concepts	• General definition of energy • Laws of energy • Energy transformation
Energy Use	• Consumer energy usage • General energy consumption trends • Health and safety factors
Energy Tradeoffs and Implications	• Quality of life • Energy resource limitations • Energy development impacts/constraints
Energy Efficiency and Conservation	• Impact of technology on energy • Impact of behavior
Sources & Types of Energy	• Energy sources • Renewable versus nonrenewable • Types and forms of energy

Table 1: Core Energy Topics

A quick overview of themes links main concepts with key bullet points. For instance, basic energy concepts includes general definitions, laws and transformation. Energy use has to do with consumer patterns, general consumption trends, and health and safety factors. Looking at energy tradeoffs and

implications calls forth deeper discussions related to quality of life, resources, and development impact and constraint. Considering efficiency and conservation brings into play the impacts of behavior and of technology on energy. And evaluating sources and types of energy opens a study of renewable vs. non-renewable resources in the context of forms of energy.

Refining the Questions and Metrics

Once we had validated our five core energy topics, we refined a series of questions for each one using historical energy literacy studies, academic exams, and research databases. From the initial question pool, we selected a representative set of 29 for evaluating a high school senior or recent graduate's understanding of energy.

To calculate consistent scores for each participant, we developed an evaluation metric, which takes the average of the percentage of correct responses for each of the five core energy topics. The result, then, becomes the participant's energy literacy score. Given that the number of questions relating to each core energy topic was not equal, a simple average of correct responses in each category was used to prevent the overweighting of any category.[*] The overall score is therefore an average of the components, not the average of all the questions.

To ensure we did not overlook the design, we also tested a scoring model with equal weighting of the questions (instead of categories), and it delivered minimal differences in results or outcomes. Future sampling and analysis will provide additional data that will help determine if this simple average approach is the best measurement of energy literacy.

Piloting and Pivoting

At that point, it was time for a maiden voyage. To test the framework validity, we administered a pilot survey to a random subset of the target population: a demographically-diverse group of nearly 400 high school students and recent graduates. Our goals were to ensure that survey respondents could easily understand the questions and manage the length. After this pilot, we were able to make refinements and clarifications to the assessment questions.[6]

In order to determine which questions were the best indicators of energy literacy, we analyzed the pilot data for:

- Correlation between questions and overall score
- Statistical analysis of the response distribution
- Attitudinal and behavioral profiling via factor analysis

The data from this pilot study enabled us to make vital refinements to the framework and thereby ensure the survey assessment could properly, holistically evaluate the core issues. We ended up removing two questions, and refining existing wording to clarify, articulate, and remove any ambiguity.

Reaching a National Sample

During a period of four weeks, the survey assessment was administered to over 2,000 high school seniors and recent graduates.

We were adamant about ensuring proper student representation, so we enforced quotas during data gathering to balance distribution of responses across census-defined attributes, including the following:

- Geographical regions
- Age
- High school status
- Household income
- Gender
- Ethnicity

[*] This is the same model the ACT uses to calculate its composite scores.

We recruited students through a leading consumer panel company that had the capacity to randomly sample the target population. Partnering with a panel provider ensured high data integrity and a sample of students that is representative, reliable, and engaged.[7]

Our population seems to lean slightly toward students who either currently attend college or plan to attend—with 88% choosing one of those responses, compared to a nationwide average of 66% of high school students who go on to attend college—this likely indicates a portion of the population who don't actually enroll, although they plan to attend college. In short, we do not expect this to impact or skew the data.

Participants age 18 years and older could complete the entire online assessment themselves. Participants under the age of 18 required parents' responses for certain demographic questions, as well as parental consent to their participation in the assessment.

National Energy Literacy Results

The remainder of this paper focuses on results and recommendations. We'll break down results into energy literacy scores, demographic differences, and attitudes and perceptions.

Energy Literacy Score

The overall average energy literacy score for high school students and recent graduates is 48.8 out of a maximum score of 100. The distribution of scores is normal.

The scores' normal distribution is an important indicator of the scoring metric's usefulness. For instance, typical assessments completed by high school students, such as the SAT and ACT, also have a normal distribution.[8] Literacy scores varied across the five core energy topics, with students most knowledgeable about energy efficiency and conservation (63.2) and least knowledgeable about energy use (31.1). Figure 1 provides greater detail regarding the overall assessment score.

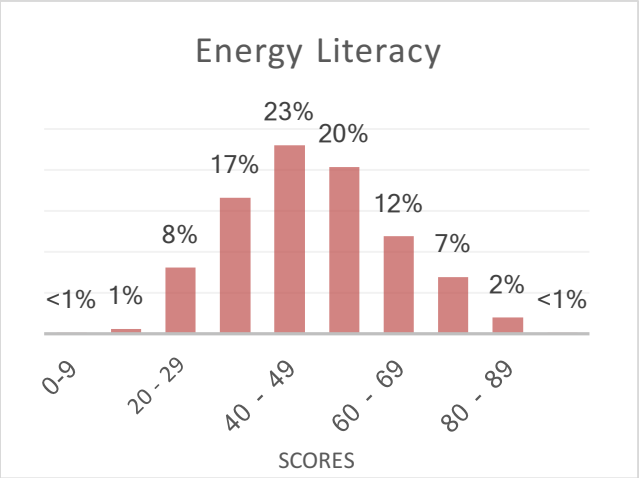


Figure 1: Assessment Scores

Demographic Differences

The overall energy literacy score varied substantially across certain demographic groups by age, ethnicity, household income, political affiliation, geography, and parent education.

Age. Students 16 years of age were much less knowledgeable about energy (41.8) than were high school seniors and recent graduates over the age of 16 (49.4). Although the sample of 16-year-old students was small, this result suggests that the gains from education during this time are significant.

Ethnicity. Asian and White/Caucasian respondents had an average energy literacy score of 51.7, which is more than 5 points greater than any other ethnic group. Black or African-American high school seniors and recent graduates received the lowest average energy literacy score (42.0).

Household Income. Students who resided in home with a household income greater than $100,000 had a higher energy score (53.3) than those with a household income between $50,000 and $100,000 (50.0), and a much higher energy literacy score than those with a household income less than $50,000 (45.1).

Political Affiliation. Students who self-identified as either very liberal or somewhat liberal had a higher energy literacy score (51.4) than those who self-identified as either very conservative or somewhat conservative (48.3).

Geography. Students living in an urban location received a lower energy score (44.3) compared with those living in a suburban or rural location (50.5). This is partially explained by socioeconomic differences between cities and more suburban/rural communities. It is also likely that cultural differences play into this discrepancy, with those in urban areas potentially having less direct experience with the topics tested.

Parent Education. Students who come from a family in which at least one parent earned at least an Associate's degree scored higher (51.9) than those who parents earned a high school degree or less (45.3).

It's not surprising that several demographic patterns above mirror patterns in SAT scores, indicating that some of these differences across groups are related to overall educational achievement differences and not just energy literacy. The most affected categories are Ethnicity, Household Income, and Parent Education.[9]

These patterns show that energy literacy education among lower socio-economic status and minority students is subject to many of the same difficulties faced in other academic areas. Successful approaches used elsewhere to shrink this gap may also apply to energy literacy.

Energy Attitudes and Perceptions

In addition to the knowledge-based assessment designed to deliver the energy literacy score, the survey included 22 questions that focused on the attitudes and behaviors of high school seniors and recent graduates toward energy. These were designed to track trends and enable categorization in broad thought patterns.

We used factor and cluster analyses to segment the surveyed population into four distinct groups, each with varying levels of engagement and differing perceptions of energy. The four personas are agent of change, mindful wanderer, big talker, and indifferent onlooker.

Agent of Change. These students place a higher priority on energy than others do, and they are fairly engaged across multiple areas of energy. They perceive energy as a critical component of the nation and are the most environmentally-focused segment. Being fairly vocal about expressing their opinions on energy, they tend to take responsibility in making a difference when it comes to matters of energy. They are the most knowledgeable about energy efficiency and conservation, as well as about the sources and types of energy.

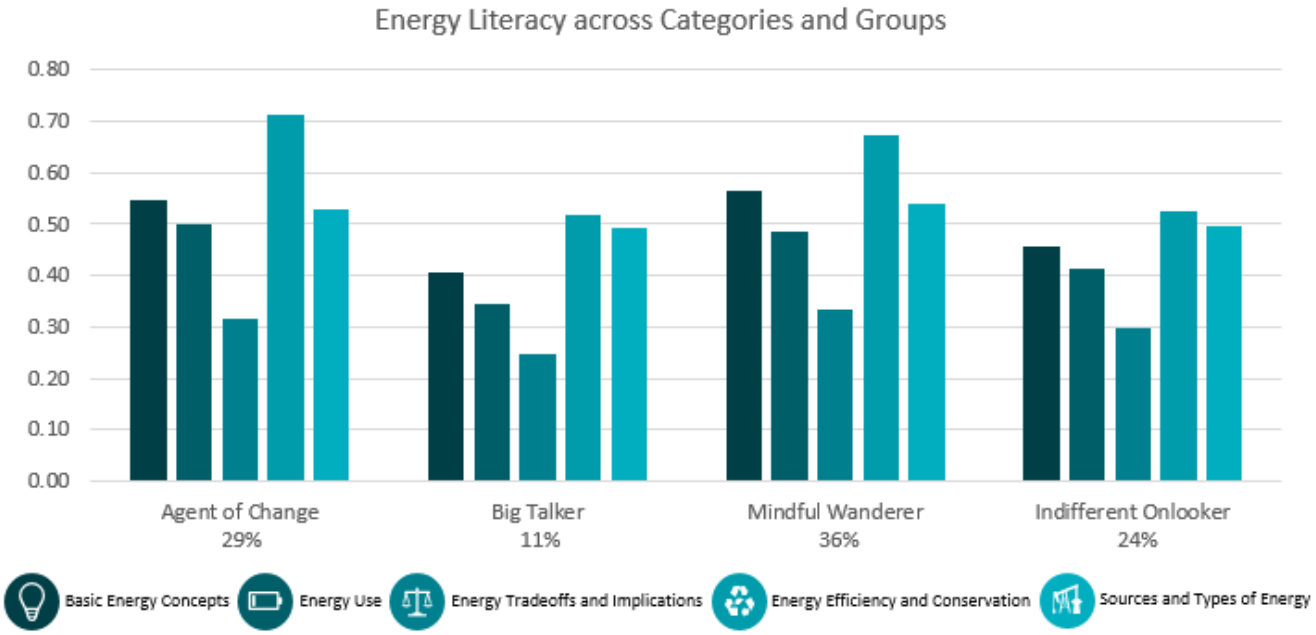
Mindful Wanderer. This is the largest of all segments, harboring over one-third of students. These students see the importance of energy, but are unsure what they can do to get involved or make a difference—perhaps because they feel their impact on the bigger picture is too small. This group also edged out the Agent of Change group with the highest overall energy literacy score.

Big Talker. At approximately 11% of students, Big Talkers represent a smaller segment of high school seniors and recent graduates. Big Talkers agree that energy is important, but are unwilling to change many energy-related behaviors. They place a high priority on their personal comfort and convenience, and are less inclined to change their behavior if it costs them their comfort. This segment received the lowest energy literacy score, as well as the lowest score in the energy use topic.

Indifferent Onlooker. When it comes to energy, this group does not seem to care much. When asked about energy topics, they don't express a strong opinion either way. Their energy literacy score is below the average and they express seeming neutrality—no excitement—toward any energy-related topic.

Figure 2 below provides an energy literacy breakdown per student segment.

Behavior Modification. The four segments vary in their behaviors, with Agents of Change most likely on average to take action to conserve energy.



Action Plan. When it comes to topics of energy, the Agents of Change are not only convinced that energy is important, but are also relatively engaged in energy-related topics. It will be important to leverage the enthusiasm of the Agents of Change to help educate the others. For the time being, the other three groups are not sufficiently convinced of the importance of energy and are not actively engaged in discussions related to energy. This represents an opportunity to engage with students on the importance of energy policies and behaviors for the future of the community.

Energy Actions and Behaviors

When it comes to taking action to conserve energy, roughly a third of students report actively engaging in multiple behaviors that make a difference. Most students are turning off lights before leaving a room, but they are less likely to be doing more impactful activities, such as traveling without a car and actively searching for products that are more energy efficient. Table 2 shows greater detail.

Indifferent Onlookers are least likely to take measures to reduce their energy usage.

Energy Behaviors	
Turn off all lights before leaving a room	**81%**
Unplug electronic devices that are not being used	**37%**
Consciously participate in carpooling	**34%**
Encourage friends or family to be more energy efficient	**32%**
Consciously choose to travel without a car (e.g., walk, bike, public transport, etc.)	**30%**
Actively search for products that are more energy efficient	**28%**

Table 2: Energy Behaviors

Research. In the survey, students were provided a list of energy-related topics and asked which they were most likely to research over the next six months. They reported that they are most likely to

research topics related to energy efficiency and the environmental impact of energy actions. About one in five students in the survey reported that he or she is unlikely to gather any information on energy in the next six months.

Information Sources. For information about energy, students are most likely to first turn to a search engine and are nearly twice as likely to use a search engine as almost any other information source.

Secondary sources, which about a third of students would use, include family, government websites, encyclopedias, industry websites, and professional profiles on social media.

Students do not always turn directly to the sources they trust the most for information on energy. For example, students trust government websites, scholarly databases, and textbooks more than search engines, but are more than twice as likely to use a search engine in their search for information. Students are least trusting of the most informal sources of information, including social media, friends or classmates, and blogs.

Conclusions and Recommendations

The most obvious conclusion of this survey is that energy literacy needs to be a more intentional area of study for K-12 students. High school seniors and recent graduates have some base knowledge—especially among specific demographics—but many are entering adult life without sufficient information to participate actively in the broader discussion and make a sustainable difference. Energy literacy can be improved by specifically addressing topics of energy in the classroom as well as in the home. Then efforts should be measured and revised in order to have the greatest impact.

Improving Energy Education

Survey results indicate that there are real opportunities for curriculum refinements to improve energy education. The assessment suggests the need for strengthened energy-related learning standards and improved energy-related curricula in schools to further educate students on core topics. Educators need support to employ strategies that improve student understanding and awareness, such as: technology, connection with industry, opportunities to learn, and community investment.

Technology. One way to improve energy education is through the use of new materials and tools. Technology such as online videos can create more engagement with students.[10] Another idea is to use real-time displays in conjunction with smart meters to allow children to see energy consumption in real time. Informative or even game-type apps can be used to help students engage with energy issues. These could potentially fulfill a niche by providing accurate, age-appropriate, and non-search-engine-based energy-related information.

Connection with Industry. Another potential way for students to learn about the energy industry is from those working in the sector. Having exposure to different people who are involved closely with energy production and distribution provides students with interactive learning. Oftentimes energy companies have dedicated energy workforce development efforts, providing an opportunity to facilitate this kind of exposure.

Opportunities to Learn. The variance of energy literacy scores across demographics should be a topic of conversation to identify what can be done to ensure K-12 students are all provided equal opportunities to learn about energy. Strategies that have proven effective in addressing these concerns in education in general may be adopted to successfully address this deficiency. Moreover, such strategies need to not only focus on knowledge attainment, but also on creating opportunities for students to engage with one another in energy-related discussions, and also to turn energy knowledge into energy action.

Community Investment. Investing in the community is a powerful tool to increase awareness of the important role energy plays in everyone's life. The Department of Energy, state agencies, and numerous energy industry players promote and implement

energy literacy themed programs for children and adults.[11] These programs are engaging, and sometimes have some competitive or challenge aspect. As good as these programs are, however, a much stronger commitment is needed from all of the above actors if energy literacy is to be truly strengthened.

Customizing an Encouraging Message for Homes

Energy literacy is taught best both in school and at home. Research suggests that students who get involved with energy issues at home with their families have better energy savvy behaviors. Prior research into children's understanding of energy conservation has shown that awareness programs that target both children and parents are most effective in encouraging cooperation and change.[12] All home-related energy literacy efforts should provide encouragement and should be customized to the specific family environments.

Tone. Encouragement tends to elicit a more positive reaction than does criticism, so both students and parents would benefit from an educational program that promotes the positive aspects of energy literacy. Precautions should be taken to prevent children feeling guilty about their family's energy use.

Customization. Care must also be taken to tailor information to students and their families' specific situation. Research has shown that the most effective energy awareness communications present information in a clear and positive way without seeming condescending or critical.[13]

It is very important that parents feel like the information they receive—whether from their children or directly from educators—is sensitive to their needs. A family that owns a single-family house is much more likely to respond to a message about making their home more energy efficient or conserving energy. In contrast, a family that lives in multi-family housing is less likely to respond positively.

Measuring and Affecting Outcomes

Measuring the outcomes of these initiatives is just as important as the initiatives themselves. Accurate measurement at each stage of a new project's implementation will ensure that each part of the project is correctly evaluated. Without proper measurement and benchmarking, a sustainable increase in energy literacy will be difficult to achieve.[14]

Future studies may combine the results of this survey with implementation science—the study of factors that influence full and effective use of innovations in practice. This combo may offer more detailed recommendations, such as adaptive grouping and coaching, for helping energy initiatives gain long-term traction among high school students.

Using the energy assessment survey with ongoing cohorts will enable stakeholders to measure the effects of both local and national campaigns to improve literacy. We may notice shifts in the attitude and behavior categories over time as greater numbers of students become informed and involved in energy-related issues. Growth in these areas will produce young adults who are more responsible for their own energy consumption, and more dialed into the energy policies that are such critical components of national and global politics.

NEF is committed to driving real change for communities, especially among the future leaders of the United States. This national energy literacy study offers a framework for looking anew at core energy issues, and provides an actionable foundation to springboard initiatives and help students gain a better understanding of energy basics, sources and types, usage, tradeoffs and implications, and efficiency and conservation.

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