

Designing Resilient Energy Education Programs for a Sustainable Future

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Abstract: Effective teacher professional development in energy education is essential to creating a sustainable future. This article highlights and describes three key components of the Wisconsin K-12 Energy Education Program (KEEP) that have led to two decades of increased statewide energy literacy. The success of the program can be attributed to supportive partnerships that guide staff, the development of an adaptive conceptual framework, and a professional development network for teachers. We offer these components as a guide for other energy education programs to promote future successes in teacher professional development in energy education.

Key Words: Conceptual framework, Energy education, Organizational resources, Partnerships, Professional development

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Introduction

Energy education has been and continues to be a rapidly changing field. Education programs need to be responsive to changes in energy technologies and consumption patterns. This paper describes key components that one program, the Wisconsin K-12 Energy Education Program (KEEP), utilized to create and offer relevant and practical professional development for teachers.

KEEP is a program within the Wisconsin Center for Environmental Education (WCEE), which is located within the University of Wisconsin-Stevens Point College of Natural Resources and the University of Wisconsin-Extension - Cooperative Extension. It is a professional development program that leverages teacher education to improve and increase energy literacy in Wisconsin's K-12 schools. KEEP started in 1995 as a three-year grant funded project; twenty years later this program still exists and has become an international model for energy education. School systems and energy resource managers have come to recognize KEEP as an essential resource for improving energy education in Wisconsin. What happened to enable KEEP, destined to be a short-term project, to become a long-term program? The key lies in starting with a strong partnership and then creating a proactive conceptual framework that can be reactive to stakeholders' needs and interests. The framework was used to direct program design, featuring teaching resources and courses for teachers. The outcome of the partnership, framework, and professional development is a network of empowered teachers who feel capable and motivated to provide students with meaningful and relevant energy education. An added benefit of this energy education program is that it contributes to statewide energy savings. Over 6000 teachers in Wisconsin have received KEEP support services and materials through graduate-level, university accredited courses. In this paper, we will describe how these teachers have potentially taught over three million students about energy since KEEP started offering courses in 1997. The graduates of KEEP courses are empowered to integrate energy concepts into their classroom lessons year after year, exposing an increasing number of students to energy education. This enhanced interest in teaching about energy can be seen in this comment from a teacher (personal communication, April 10, 2013) who participated in a KEEP course:

“As a first grade teacher, I think it is important that my students not only learn about energy but understand that there are renewable energy sources that are being used in addition to the nonrenewable sources... The activity guide has easy to use,

hands on activities to use throughout the grades K-12. It's a great start and will lead to further lessons promoting energy conservation and renewable energy.”

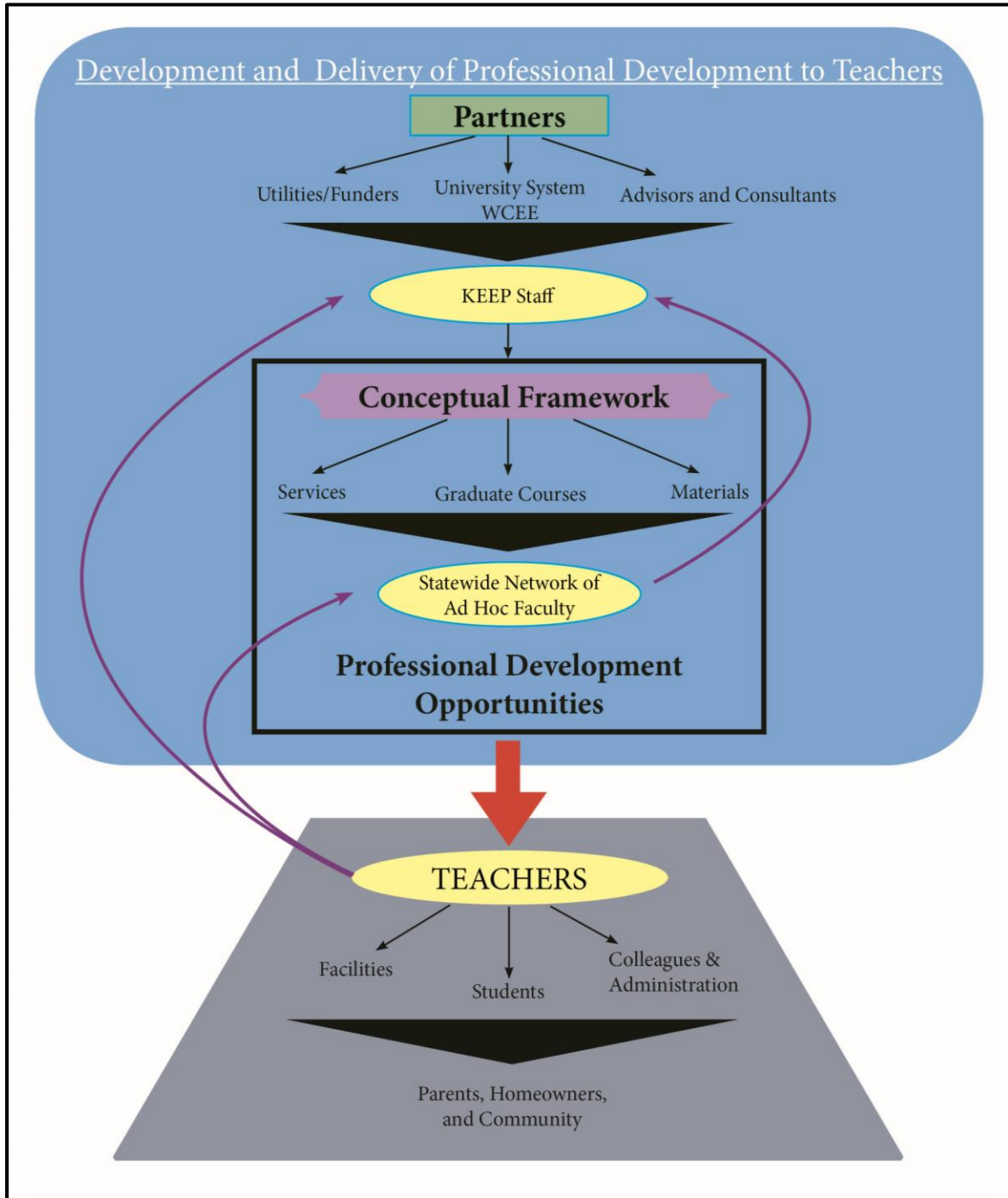


School energy team created as a result of KEEP professional development course, 2013

Theoretical Framework

Various researchers have identified different strategies and models for professional development of teachers (Darling-Hammond, 1995; Loucks-Horsley et al., 2003; McLaughlin & Oberman, 1996). According to Gamoran and Anderson (2003), the dynamic model of organizational support offers a holistic view of teacher professional development that includes interactive relationships among staff and stakeholders. Gamoran and Anderson developed this model because existing models lacked necessary components to study how schools respond to challenges. This model considers organizational resources (social, human, material) and situates teacher professional development in the middle of a flow of these resources. Not only are resources expended for teacher professional development, but resources are created as a result of the professional development.

Figure 1: KEEP's model for the development and delivery of professional development to teachers.



KEEP's approach to professional development fits within this model because of its organizational resources. As shown in Figure 1, partners, including funders and various stakeholders, form a critical social resource (in green) for program design, implementation, maintenance, and evaluation. Partners work with the WCEE to secure funds and supplies for

material resources (in purple), including personnel and operations, tuition scholarships, and activity guides and other teacher support materials. These partners also worked with KEEP to create the program's conceptual framework. This case study will explain how this framework was important for guiding and directing the design of KEEP's services, materials, and graduate courses. A statewide network of ad hoc faculty disseminate many of these resources and are part of KEEP's human resources (in yellow) along with staff and participating teachers. These individuals are part of the professional development opportunities described in this study. With support of these organizational resources, KEEP has created a statewide network of energy educators who promote energy literacy in Wisconsin. Social, human, and material resources have allowed KEEP to be both reactive and proactive to stakeholder needs and interests. This responsiveness has resulted in stakeholders becoming advocates for KEEP and playing a key role in its success over the past twenty years. Stakeholders can depend upon KEEP to improve energy education and increase energy literacy in Wisconsin.

Review of Literature on Energy Education Programs

Opinion Dynamics Corporation's (2012) review of K-12 energy education programs summarized and described nine programs according to program categories, quantified savings and claimed savings. Reviewed programs were organized into the four categories of curriculum-based offerings, curriculum-based with proactive energy savings tips for the home, curriculum-based with hands-on activities or projects directed at saving energy, and curriculum-based with energy saving kits. Notable programs reviewed were California K-12 Energy Education (E3), California School Energy Efficiency Program, Connecticut eesarts[™], Connecticut Energy Education, Kentucky National Energy Education Development (NEED) project, Ohio Energy Project, Wisconsin K-12 Energy Education Program (KEEP), Resource Action Programs' LivingWise[®] and U.S. Department of Energy's School Education Program. Wisconsin KEEP and the Kentucky NEED project were highlighted as programs that focused on dissemination and implementation of energy education curriculum but also promoted actual energy change in school buildings through distribution of CFL bulbs and measurement and data collection.

A second literature review by the Energy Center of Wisconsin (memorandum, January 11, 2013) identified K-12 energy education programs that offer best practices, quantify and claim energy savings. This review included some mentioned in the previous study and added CLASS 5's Schools for Energy Efficiency[®] program, The Energy Coalition's PEAK Student Energy Actions program, Idaho Power's Energy Wise[®] Program, and Pacific Gas and Electric Company's Energenius[®] program. This report described Wisconsin KEEP's approach as focusing primarily on empowering teachers to teach about energy efficiency and energy related issues rather than working directly with students. "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" (p. 2). The Energy Center of Wisconsin also noted that Wisconsin KEEP and Connecticut Energy Education promote green schools.

It is important for energy education programs to remain relevant. One way to stay relevant is by aligning with state and national curriculum guidelines. *A Framework for K-12 Science Education* (National Research Council, 2012) describes how science and engineering are not only intellectual enterprises but can also improve peoples' lives. Energy education content and learning activities align with many of the cross-cutting concepts of this educational framework including cause and effect, systems and system models, and energy and matter - flows, cycles and conservation. Not only is KEEP linked with this framework, but it is also

aligned with the U.S. Department of Energy's *Energy Literacy Framework* (2014). This framework was designed with the assistance of KEEP and other education partners. It includes seven essential principles and fundamental concepts of energy literacy and is used as a guide for the conceptual framework of many programs. Another way for energy education programs to remain relevant is by connecting to the daily lives of energy producers and consumers. KEEP and some of the other programs have adopted best practices to engage students and teachers in hands-on school projects, directly work with utility administrators, adopt actionable tips for the home and parental engagement, and tracking of energy data (Energy Center of Wisconsin, memorandum, January 11, 2013).

Some energy education programs such as state programs in California, Connecticut, Kentucky, and Wisconsin have the capacities to reach and impact a large number of students and teachers, but these programs and many others have also associated themselves with school systems-based initiatives. Green & Healthy Schools (Kentucky, Wisconsin), Green Schools (Florida, Missouri, Oregon, Washington), U.S. Department of Education's Green Ribbon Schools, Healthy Schools Network, Green Schools Alliance, U.S. Green Building Council's Center for Green Schools, and Green Schools National Network (information about these programs can be found through a simple web search) are just a handful of the recent school systems-based approaches that include energy education and on-site activities to improve energy efficiency and conservation. Alignment with these school-based programs is one way that energy education programs have continued to gain relevance and resiliency.

Components of a resilient energy education program

As shown in the literature review, KEEP has been referenced in a number of national studies of exemplary energy education programs. KEEP staff receive phone calls often from energy education supporters from around the world inquiring about the program's key to success. Following, we have outlined three components that have contributed to KEEP's resiliency; they reflect the social, material, and human resources outlined in the theoretical framework. The Wisconsin Center for Environmental Education worked with KEEP staff to establish these components in the program's early years to form a springboard for resiliency and growth.

Forming the foundation – a partnership for energy education

A supportive partnership, as a social resource, is the first key component of a resilient energy education program. These stakeholders, including funders, state education agencies, ad hoc faculty, and teachers, have played essential roles in the creation, maintenance, and advocacy of KEEP. The program has had many funding partners, primarily state utilities and the University of Wisconsin-Stevens Point. Occasionally, it has partnered with different industries, such as paper companies, to sponsor topic specific courses and projects.

Being housed on the campus within the Wisconsin Center for Environmental Education, the University and the WCEE are key supporters of KEEP operations and administration. Through rate payer dollars, the utilities have made a substantial investment in KEEP by providing funding for staffing and scholarships. The scholarships are incentives for teachers to participate in KEEP courses and to improve their energy education teaching competencies. By offering scholarships, funding partners demonstrate their commitment to promoting energy literacy in their community. Like any investment, the funders want to make sure their support is fruitful and effective. Therefore, it is essential that funders, as key stakeholders, play a partnership role in KEEP. The key to this partnership is active communication. Formally,

communication started with KEEP through a steering committee of partners and now occurs during annual advisory committee meetings. More regularly, communication takes place through work on collaborative projects, workshop presentations, and general correspondences.

Using insights from its funding partners and other stakeholders, the staff continues to work proactively to create programs that anticipate future needs and interests of teachers and energy stakeholders. As noted by Anderson (1996), planned collaboration between a program's partners allows it to reflect on actual classroom experiences to re-assess the educational values and beliefs to continually adapt education programs. Being flexible to the needs and interests of energy education stakeholders has helped make KEEP a resilient program.



KEEP Ad Hoc instructor and Utility representative at community energy fair, 2013

Framing the program - a conceptual guide

Another key component of KEEP's success has been the conceptual framework it developed when the program first began, *A Conceptual Guide to K-12 Energy Education in Wisconsin* (KEEP, 2003). First published in 1996, this resource contains nearly sixty concepts that provide the foundation for curriculum development. The framework includes concepts that address a variety of different issues and viewpoints. KEEP staff conducted an extensive literature review to identify the concepts and worked with their partners to gain insights into energy resource management from many perspectives. The concepts within the framework are organized under four themes:

1. We Need Energy,
2. Developing Energy Resources,
3. Effects of Energy Resource Development, and
4. Managing Energy Resource Use.

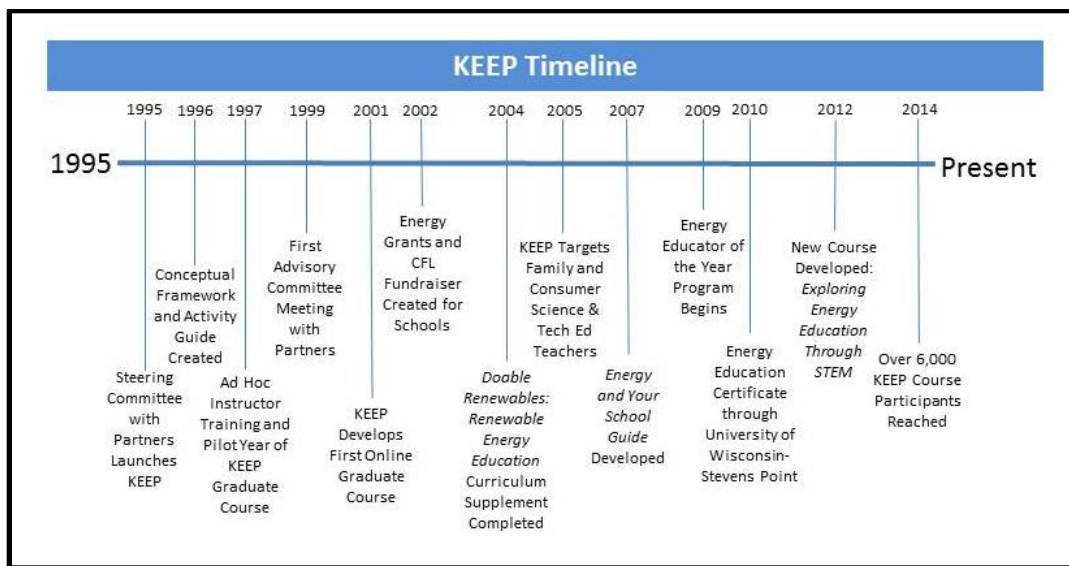
The themes are designed to build upon each other; understanding the concepts in one theme support comprehension of subsequent themes. Patterned after the goals for curriculum development in environmental education (Hungerford, Peyton, & Wilke, 1980), they start with

awareness to knowledge, continue with values analysis, and conclude with participation strategies to conserve and use energy efficiently.

Throughout KEEP's history, this framework has been used to guide many aspects of program design. Initially, it directed the development of an activity guide, which in turn determined how the pilot course was organized. The guide and course primarily addressed awareness and content knowledge related to the framework (the first and second themes). As the program advanced, it was able to develop other support services and materials to address the other themes. Through an online course, web-based resources and discussion forums have provided teachers and their students with opportunities to discuss and analyze energy issues (theme three). For the fourth theme, the partnerships once again played a critical role implementing the program of KEEP. Their guidance has helped launch initiatives that actively involve teachers and their students in saving energy in their school and homes. One project involved creating *Energy and Your School* (KEEP, 2009), an activity guide focusing on the school building as a learning resource. Over the years, insights from state utilities and other energy resource managers have helped the framework remain relevant and effective. It has been revised twice, most recently in 2003.

This foundational document provided the necessary structure for advancing energy education efforts that included writing additional supplemental materials, offering creative outreach activities and programs, and designing additional graduate course options. Figure 2 presents a timeline pointing out some social and material resources available from KEEP. It begins with the steering committee of partners and the conceptual framework and then highlights some of the projects and activities that have taken place since. The next section describes how KEEP's human resources disseminate materials and services through its professional development network.

Figure 2: The figure below highlights selected program activities accomplished since KEEP's inception



Fostering energy literacy - professional development

A professional development network is the third key component of program resiliency. Energy is an abstract, often intimidating topic, and may not seem relevant to teachers outside the discipline of science. Based on the research that teacher education is needed to help teachers overcome barriers (Ham, Rellergert-Taylor, & Krumpe, 1988; Lane, et al., 1995; Monroe & Cappeart 1994; Paul & Volk, 2002) and the importance of relevance and meaning to motivate interest in the environment (Chawla, 1998; Kollmuss & Agyeman, 2002; Sia, Hungerford, & Tomera, 1986), the human resources of KEEP worked together to create programs that would be meaningful and attractive to teachers. Being housed within the University of Wisconsin-Stevens Point enabled KEEP to create university accredited courses. Teachers are interested in earning graduate credit to sustain their license and move up the pay scale. Tuition scholarships provided through KEEP stakeholders made these courses even more attractive to teachers. The opportunity for inexpensive graduate credit drew teachers in and, to sustain interest, KEEP offered various other supports such as web-based teaching aids, student contests, newsletters, and grants that are noted in the timeline (see Figure 2).

On average, twenty-nine KEEP courses are offered each year. How can a small number of staff located in central Wisconsin provide professional development to teachers statewide? The answer lies in KEEP's ad hoc faculty network.

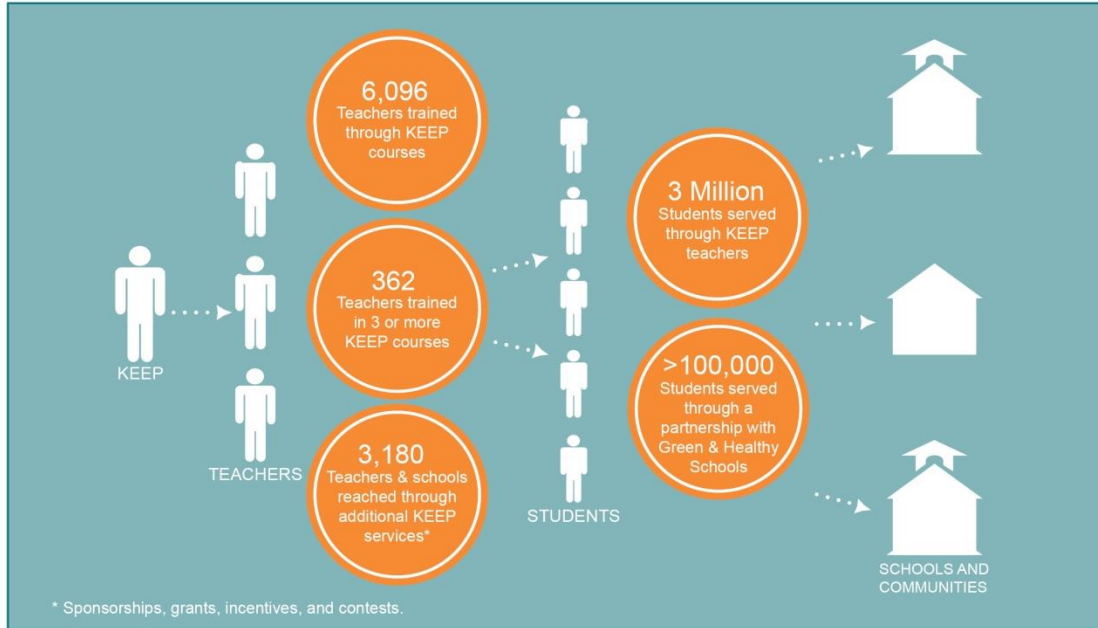
To disseminate KEEP's professional development opportunities, KEEP staff worked with its steering committee to identify qualified individuals in energy resource management and teacher education to become ad hoc faculty. These faculty were strategically located throughout the state to ensure teachers statewide received access to KEEP support services and materials. These efforts resulted in an effective program as defined by Kerlin (2012): one that has easy access to repeated and linked training workshops and courses, individualized support, along with sustained support in the classroom from content and education experts. With this multi-faceted approach to providing a comprehensive network of support services and materials for teachers, KEEP builds the capacity of any teacher to become an energy education leader.

Teacher education has been the key resource dissemination strategy for KEEP. Teachers work daily with students and best understand their learning needs, using and creating organizational resources. Through KEEP, they learn how to best tie energy concepts into their curriculum. The main reason for seeking energy literacy through teachers is simply that more students can be reached through teacher education. KEEP staff calls this its multiplier effect. By using the ad hoc faculty network, many more students receive energy education directly through the classroom teacher. In KEEP's first twelve months of offering courses under the initial grant, nearly 400 teachers participated. Some of these were elementary school teachers who have around twenty students in the classroom and others were secondary level teachers with multiple classrooms teaching around 100 students a year. Roughly averaging these two groups of teachers, each teacher reaches around sixty students a year. Therefore, the first population of teachers who attended the KEEP course potentially taught 24 000 students in their first year!

Each year, a new set of teachers participate in courses while teachers from previous years continue to implement activities they experienced in the classroom. As shown in Figure 3, through the multiplier effect, over 6000 teachers have been through courses, potentially having taught over three million students by the sixteenth year of offering classes. Of course there are exceptions and variances to these calculations: teachers retire, quantity and quality of energy content vary, subject and grade level differences, student learning, and so forth. Nonetheless, the

potential for reaching the most students more consistently through the school year is the main reason KEEP is an advocate for teacher empowerment.

Figure 3: The KEEP Multiplier Effect



Results – energy literate teachers and their students

Teachers who have received professional development through KEEP and use its resources with their students are ultimately the program’s resiliency. Ideally, because they have become empowered by their experiences and support, they can continue to educate their students and peers about energy even if KEEP should cease to exist. They have become cheerleaders for and advocates of energy literacy. As one high school science teacher (personal communication, May 8, 2014) noted:

“[KEEP] gave me the confidence to use STEM activities in my classroom, by understanding the process and what I needed for materials, and knowing it would work and be fun. I have used all of the ones we went through in my classroom already and am excited to look into more activities involving STEM. The kids have loved it, and so have I. It was worth the time, and I’ve become a better teacher because of it.”

A network of teacher energy education leaders has emerged in Wisconsin. The program has found that as teachers became more advanced in their energy content knowledge and experiences, they became interested in providing students with more opportunities to make their schools and homes more energy efficient. Consequently, they report needing help building school community partnerships on energy issues. Other teachers have indicated they would like to integrate more extensive and in-depth energy practices in their school districts. In response, KEEP staff worked with its social resources to create initiatives such as grants, awards, incentives, and contests that serve even more teachers and their students. KEEP continues to enhance its evaluation and assessment strategies to provide more evidence of impact and long-term energy literacy. Some general strategies used are course evaluations, pre-post assessments

for course participants (implemented in 2013), graduate student research and partnering with external evaluators on occasion throughout its 20 year history.

Today, KEEP has a suite of over seven graduate courses on energy education topics for teachers along with other material resources which advance the reach and depth of energy education in Wisconsin. Over 300 teachers have taken three or more KEEP courses and nearly twenty of these teachers have earned an Energy Education Certificate through the University of Wisconsin-Stevens Point. The certificate enhances a practicing teacher's portfolio by reflecting comprehensive professional development and experiences in energy content and teaching competencies. These teachers have the potential to become leaders in their districts. KEEP has been fortunate to have partnerships that have enabled staff to meet teachers' needs and interests, further developing this network of leaders.



Teachers tour hydroelectric facility during summer workshop, 2013

Conclusions and Recommendations

This case study has featured material, human, and social resources that have been essential for KEEP's resiliency. The development of partnerships with state utility companies, the production of an energy education conceptual guide, and the creation of a sustained professional development network have led to continued program success. Adoption of these approaches and features may help other energy educators develop and sustain large-scale energy education initiatives.

There are other aspects of the program's organizational resources that have contributed to program success that are beyond the scope of this paper to discuss. However, it should be noted that ongoing formative assessments have been crucial to evaluating the program's effectiveness (Lane, Mollica, & Windjue, 2013). These assessments include regular strategies to gain teacher feedback as well as external reviews to evaluate program effectiveness. The outcomes of these assessments have helped the staff revise program development strategies and ensure stakeholder satisfaction. Another aspect of partnerships is working collaboratively, rather than competitively,

with other state education programs. For example, strategic collaborations with programs like the Wisconsin Green & Healthy Schools program is proving to be a good strategy for advancing KEEP's reach in schools.

The components discussed in this paper have had many subsequent beneficial outcomes. One benefit of KEEP's multiplier effect and network of energy education leaders is that it has contributed to statewide energy savings. Course components such as creation of energy action plans and opportunities for mini-grants encourage teachers to work with facilities staff to carry out energy efficiency upgrades and implement energy conservation initiatives in their district.

For over twenty years, KEEP staff and stakeholders have recognized how organizational resources have time and time again helped sustain their program. Other effective energy education programs will recognize how the components discussed in this paper have benefitted their state's energy literacy. They may find ways to incorporate some of the strategies KEEP has used to enhance their program just as the KEEP staff welcome learning about the organizational resources of other programs.

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Icon Image for Article



Original artwork for the KEEP Activity Guide (Linda Godfrey, 1998)