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Competencies for Advancing Transformations Towards Sustainability

Aaron Redman[1,2,3]* *and Arnim Wiek*[1,2,3]

[1]School of Sustainability, Arizona State University, Tempe, AZ, United States, [2]Center for Global Sustainability and Cultural Transformation, Leuphana University of Lüneburg, Lüneburg, Germany, [3]Center for Global Sustainability and Cultural Transformation, Arizona State University, Tempe, AZ, United States

Advancing transformations towards sustainability calls for change agents equipped with a new set of competencies. Such sustainability competencies have been articulated with multiplicity and ambiguity, which is counterproductive to joint and accelerated progress. A unified framework of sustainability learning objectives would provide guidance to students, educators, and administrators of sustainability programs. To this end, we carried out a systematic review of the relevant literature. After scanning thousands of publications, we identified over 270 peer-reviewed articles of highest relevance, spanning two decades. Despite appearance otherwise, we found that there is a high level of agreement among scholars over the sustainability competencies that students should be trained in. Expanding on the five key competencies, namely, systems-thinking, anticipatory, normative, strategic, and interpersonal competence, that have gained widespread use, this article synthesizes the new suggestions made over the past decade into a unified framework. It centers on 8 key competencies in sustainability (the 5 established and 3 emerging—intrapersonal, implementation, and integration competence), which are complemented by separate disciplinary, general, and other professional competencies. This comprehensive framework of key competencies in sustainability is applicable across disciplines and can guide faculty, students, and practitioners in their joint efforts to advance transformations towards sustainability.

Keywords: learning objectives, sustainability education, transformations, change agents, key competencies in sustainability

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Charles University, Czechia

Correspondence:
Aaron Redman
aaron.redman@asu.edu

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INTRODUCTION

To achieve the Sustainable Development Goals (SDGs) by addressing persistent sustainability challenges such as climate change, biodiversity loss, and socio-economic injustices requires ambitious and whole-scale transformations of societies worldwide (UNESCO, 2017; Scoones et al., 2020). Facilitating these transformations will require novel approaches (Linnér and Wibeck, 2019) that ought to be carried out by change agents who are educated in sustainability and sustainable development (Franco et al., 2019; Redman et al., 2021). In response, the number of sustainability programs at universities and colleges has substantially increased worldwide—to over 1,500 in the United States alone over the past decade (Weiss and Barth, 2019). Yet, critics have long noted that most of this education hews too close to the status quo (Orr, 2003) and graduates of these programs are equipped only to make incremental improvements, instead of being the change agents capable of advancing transformations (Gordon et al., 2019). The characteristics of such *transformational* change agents should be reflected in the learning objectives of sustainability programs.

Yet, there still remains a lack of clarity and coordination regarding a unified framework of sustainability learning objectives (O'Byrne et al., 2015), which undermines effectiveness, innovation, and legitimacy of such programs (Vincent and Focht, 2009). Guidance is unlikely to come via high-level policy (Mochizuki, 2016), as neither the UNDESD, nor the more recent SDG 4.7, which calls for Education for Sustainable Development (ESD) globally (Giangrande et al., 2019), provide any explicit learning objectives, let alone a coherent framework for advancing transformations. In contrast, UNESCO has articulated how key competencies in sustainability can be utilized to develop educational programming around all seventeen of the SDGs (UNESCO, 2017).

Scholarly reviews of university sustainability programs (Trencher et al., 2018; Salovaara et al., 2020) and expert surveys (Rieckmann, 2012; Demssie et al., 2019; Brundiers et al., 2021) have brought those perspectives into the scholarly literature. At the same time, the growing number of scholarly works on sustainability learning objectives in diverse disciplines, from science and engineering to teacher education, has remained dispersed and thus does not offer coherent direction. Some literature reviews have been published, but these have either been large and systematic, yet, without a thorough synthesis (Hallinger and Chatpinyakoop, 2019), or synthesizing, yet, small and non-systematic (Lozano et al., 2017). In summary, there is a need for a comprehensive, systematic review which goes beyond description. This study offers such a review and synthesizes a unified framework of sustainability learning objectives to provide guidance to sustainability educators and accelerate transformations towards sustainability.

METHODS

Synthesizing a growing body of research such as that on sustainability learning objectives is best done through a systematic literature review (Snyder, 2019). We followed the procedures laid out by Fink (2014) to be systematic, explicit, comprehensive and reproducible. One of the goals of this study was to be as thorough as possible and identify almost everything that has been published on sustainability learning objectives. In order to be sure that definitional differences did not accidentally exclude relevant articles, we searched for synonyms of learning objectives. We sought to draw from as broad a pool of publications as possible; thus, we conducted our search on Web of Science, SCOPUS, ERIC, and Google Scholar. Based on other sustainability education literature reviews, we expected these databases to provide comprehensive coverage.

The exact search strings can be found in the supplementary materials, but in brief, we were looking for publications through the end of 2020, in English which described specific learning objectives (e.g., competencies, capabilities, and attributes) for sustainability education programs (degrees, courses, etc.). In line with the transformational framing of this review, education focused exclusively on incremental behavior changes (e.g., how to sort recycling material) were excluded. The identified publications went through an iterative screening process (**Figure 1**) to create a final collection of articles for review. At each stage, publications were only excluded when they clearly did not fit the above characteristics. For final inclusion, descriptions of specific sustainability learning objectives had to be identified in the text. In addition, each of the databases was screened for articles published or in press until August 2021, and the most relevant were included in the overall qualitative analysis.

For the analysis, bibliographic information as well as any information coded or extracted from the publications was imported into R (R Core Team, 2020) for analysis. A variety of analyses were performed such as text mining of the titles, keywords, and abstracts, citation analysis, and others. The learning objectives and their descriptions were extracted from each publication for both quantitative and qualitative analysis. The overall collection was also reviewed and synthesized qualitatively. Specifics and more details on the methods used for analysis can be found in the **Supplementary Materials**.

RESULTS

Study Selection

After duplicates were removed, we were left with 4,520 bibliographic entries to review. The iterative process is described in more detail in the PRISMA diagram (**Figure 1**), but essentially, we first made several passes to exclude those publications which were clearly irrelevant before reviewing the remaining ones. The collection ultimately contained 272 publications used for complete analysis plus 5 more from 2021 which were qualitatively reviewed only (see **Supplementary Materials** for a full list).

Increasing Publication Efforts and the Challenge of Convergence

Publishing on sustainability learning objectives only began in earnest this millennium and has grown continuously between 1997 and 2020 (**Figure 2**). Across the most relevant publications (n = 272), many perspectives are being represented among diverse scientific journals (more than 100), with the top 3 journals accounting for about one third (32%). Over half of the sampled articles (n = 143) were written for a particular discipline including teacher education (n = 32), business/entrepreneurship (n = 29), engineering (n = 29), and many more such as design, computer science, health, tourism, facility management, agriculture/food, and construction. Geographically, the sample is far less diverse with only 9% of publications coming from outside of the OECD member countries.

This varied body of literature converges in the intention to prepare students for contributing to sustainability transformations. Publication abstracts and titles typically include phrases explicitly referring to sustainability challenges

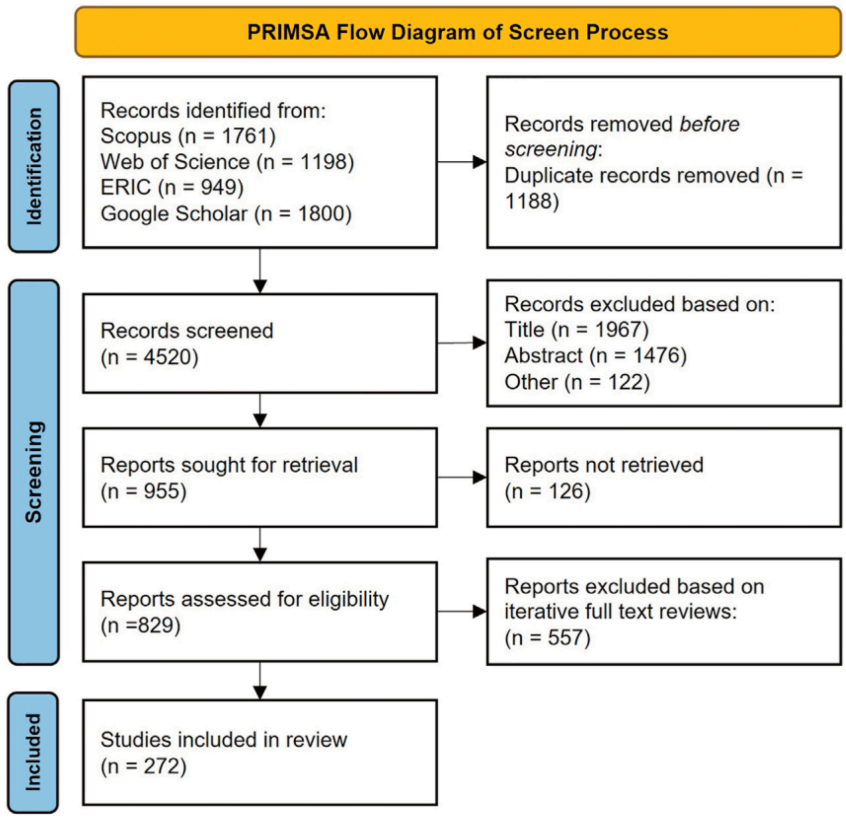

FIGURE 1 | PRISMA Flow Diagram Illustrating the Screening Process for this Study.

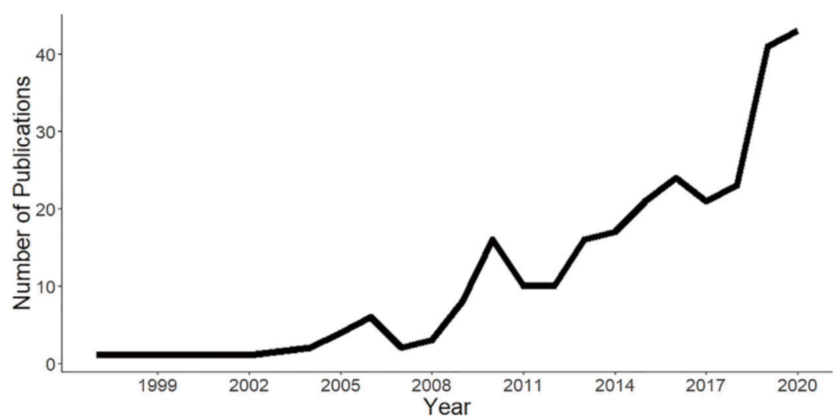

FIGURE 2 | Number of publications in collection (*n* = 272) by year (1997–2020).

(77%) and pointing to the need to address them (76%). This is grounded, to some extent, in the literature, with *Our Common Future* and the *UN Decade of Education for Sustainable Development* being the two most cited background references (by 23% of articles for each).

The conducted literature search included common synonyms for learning objectives, e.g., "literacy" (Dawe et al., 2005) and "attributes" (Barrie, 2006), with "competencies" emerging as the most widely used term (**Figure 3**). A competence is defined as "a complex combination of knowledge, skills, understanding, values, attitudes and desire which lead to effective, embodied human action in the world, in a particular domain (Crick, 2008)." Competencies are most often specified as independent of domain-specific content knowledge, which allows for articulating competencies across disciplines and professions. The competencies approach to education was broadly

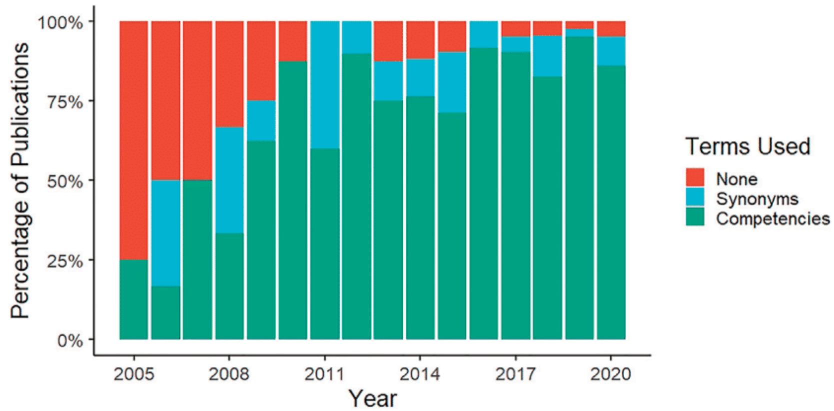

FIGURE 3 | Percentage of publications mentioning competencies versus all other synonyms ("literacy" etc.) in title, keywords, or abstract by year (2005–2020) (publications prior to 2005 (n = 10) were excluded for better presentability).

popularized beginning more than two decades ago through efforts such as the OECD-led initiative on "Definition and Selection of Competencies (DeSeCo)" (Rychen and Salganik, 2000). Yet, as late as in 2008, it was not seen as commonly used in sustainability education (Van Dam-Mieras et al., 2008), though with increased adoption since (Barth, 2015).

A common theme in the literature is that "no consensus has been reached within ESD discourses as to the process of how to identify essential abilities and as to a list of abilities seen as important" (Wolbring and Burke, 2013). Even as recently as 2021, scholars (and presumably practitioners) continue to operate as though there is "no agreement on exactly what these key competencies are" (McCarthy and Eagle, 2021). This position lends legitimacy to the current practice of continuously re-inventing sustainability competencies in the literature. At the same time, there is little explicit connectivity in the literature, with 40% of the articles (prior to 2019) not being cited by any others (in the whole sample).

Convergence on Key Competencies in Sustainability

Yet, when looking beyond terminological differences, we find convergence in the literature on what graduates and professionals need to be capable of to advance social transformations to sustainability. The 2011 review article "Key competencies in sustainability—a reference framework for academic program development" (Wiek et al., 2011) was the first articulation of this convergence. The authors synthesized from the literature a framework of sustainability-problem solving competence, integrating five key competencies, namely, systems-thinking, anticipatory, normative, strategic, and interpersonal competence. This article has been received as a unifying framework• and identified as "the most influential paper" in ESD (Grosseck et al., 2019, 26). Over the past decade, it has been cited by over 63% (n = 141) of the sampled articles published in 2011 or after (n = 225). The second most cited publication (Rieckmann, 2012) (by 25%) distills expert opinions into a list of competencies, without synthesizing a framework, while the third most cited publication (Barth et al., 2007) (by 21%) focuses on how competencies may be developed rather than offering a framework. Beyond citations, the 2011 key competencies framework has facilitated explicit convergence, being used as the full foundation in 32 articles (14% of the sampled articles published 2011 and after) and as a partial foundation in 78 articles (35%). Mapping this framework over the entire sample (n = 272) between 1997 and 2020 demonstrates convergence on these competencies (**Figure 4**). Interviews with sustainability professionals have found these competencies to be well recognized (Salovaara et al., 2020). In addition, this framework has been applied in many real-world contexts from university programs (Boone, 2015; Richard et al., 2017; Jarchow et al., 2018) to K-12 teacher training (Archambault et al., 2013; Kieu et al., 2016; Redman et al., 2018), K-12 education directly (Wiek et al., 2016; Rodríguez-Aboytes and Nieto-Caraveo, 2018), and training for in-service professionals (Thomas and Millar, 2016; Withycombe Keeler et al., 2017).

Updating the 2011 Key Competencies Framework

In the ten years since the publication of the 2011 key competencies framework (2011–2020), 110 articles were published that substantively engaged with the framework (beyond just citing it). Analysis of this body of literature identifies both insufficient receptions and productive suggestions relevant to an update (Wiek and Redman, 2021).

Indicative of the deficient, yet prevailing *list*-approach to competencies, scholars often acknowledge the relevance of the five competencies and then add a competence or two without offering how those might integrate into the framework and specifically contribute to sustainability problem solving (Heiskanen et al., 2016). Beyond the lack of adopting the *framework*-approach, many articles lack concise definitions and clear conceptual development of new competencies, a flaw called out by several other reviews (Sterling et al., 2017;

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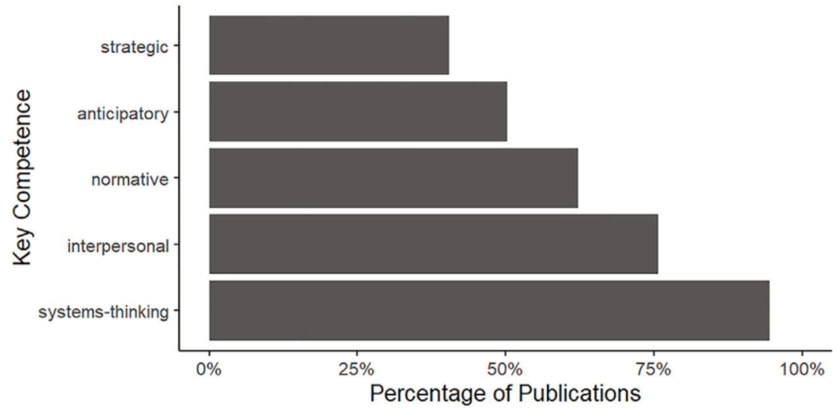

FIGURE 4 | Percentage of sampled publications (*n* = 272) on competencies that can be mapped onto the 2011 framework (1997–2020).

Galleli et al., 2019; Shephard et al., 2019; Wilhelm et al., 2019; Brundiers et al., 2021). One example is "action competence" (Mogensen and Schnack, 2010), which is frequently added to the 2011 framework, but often confounded with strategic competence (Lans et al., 2014). Another common reception is to emphasize general and disciplinary competencies such as creativity (Steiner and Scherr, 2013; Lozano et al., 2017) or critical thinking (Rieckmann, 2012; Fukushima et al., 2017). As explained in the 2011 framework (p. 211), while these are necessary competencies for solving sustainability problems, they are not *key* competencies, as they are not distinct to *sustainability* but considered learning objectives of education *in general* (Voogt and Roblin, 2012).

Yet, there have also been a number of productive suggestions to expand the framework. Most relevant are three emerging competencies (for definitions, see **Table 1**), which have been proposed with varying frequencies (**Figure 5**). *Intra*personal competence has been called out in several conceptual (Anderson, 2013; Frank, 2021) and empirical (Giangrande et al., 2019; Brundiers et al., 2021) studies; yet, there remains some disagreement on whether this is a competence (Gómez-Olmedo et al., 2020) or an underlying disposition (Brundiers et al., 2021). *Integration* competence has already been mentioned in the original framework (p. 212) and elaborated in an early update of the framework (Wiek et al., 2016); it has been mentioned frequently thereafter (Evans, 2019). The least frequent explicit proposal is for an implementation competence (see **Figure 5**). The 2011 framework focuses on the competence to *plan* sustainability problem solving, and only touches on competence to *implement* sustainability interventions and solutions. Some authors have argued that implementation competence deserves the status of a *key* competence in sustainability (Perez Salgado et al., 2018), which is in line with other more vague descriptions of strategic action competence (Frisk and Larson, 2012). There is emerging agreement that sustainability education ought to prepare students for *taking action* (Mogensen and Schnack, 2010; Frisk and Larson, 2012); more specifically, for "collective interventions" (Clark, 2016; Perez Salgado et al., 2018) towards "transformative social change" (Glasser, 2016). As indicated in the original version of the framework (*p.* 214), this is a call for *collective* sustainability problem-solving competence that goes beyond the capacity of individuals (Barth, 2015).

Framework of Competencies for Advancing Sustainability Transformations

The unified framework of competencies for advancing sustainability transformations centers on 8 key competencies in sustainability (with 5 established and 3 emerging), and is complemented by disciplinary, general, and other professional competencies (**Figure 6**; **Table 1**). As a framework, the key competencies are *not* compiled as a *list* to select from; instead, *all* key competencies need to be integrated for advancing sustainability transformations. Systems-thinking, futures-thinking, values-thinking, and strategies-thinking enable crafting sustainability action plans that yield sustainability outcomes if successfully implemented (which requires implementation competence). Inter- and intra-personal competencies (key professional competencies) enable that planning and implementation is undertaken in collaborative and self-caring ways—key factors for success (Sipos et al., 2008; Frisk and Larson, 2012). Finally, integration competence enables a coherent combination of collaborative and self-caring planning and implementation efforts, using established procedures for sustainability problem solving (Angelstam et al., 2013; Polk, 2014; Wiek and Lang, 2016; Henry, 2018). Complementary competencies are organized on two axes: disciplinary competencies complement the (content-independent) key competencies through content-dependent expertise; general competencies such as critical thinking and creativity as well as other professional competencies such as responsive project management are generic competencies (used in many different fields) that complement the sustainability-specific key competencies in efforts to advance sustainability transformations.

Competencies that fulfill important functions complementary to the key competencies in sustainability can be differentiated into disciplinary, general, and other professional competencies.

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TABLE 1 | Definition and most common descriptors from the literature for each key competence in sustainability.

Competence	Definition	Descriptors from the literature
Systems-Thinking Competence	Ability to apply modeling and complex analytical approaches: 1) to analyze complex systems and sustainability problems across different domains (environmental, social, economic) and across different scales (local to global), including cascading effects, inertia, feedback loops, and other system dynamics; 2) to analyze the impacts of sustainability action plans (strategies) and interventions (how they change systems and problems)	Understand, identify, describe, analyze sustainability challenges and problems, complex issues, effects, relationships, impacts, patterns, structures, unintended consequences, feedback loops, context, interactions, etc. across different domains (environmental, social, economic), scales (local to global), and perspectives (interdisciplinary), etc.(Connell et al., 2012; Sandri, 2013; Gray, 2018; Levy et al., 2018; Schuler et al., 2018; Mahaffy et al., 2019)
Futures-Thinking Competence	Ability to carry out or construct simulations, forecasts, scenarios, and visions: 1) to anticipate future states and dynamics of complex systems and sustainability problems; 2) to anticipate how sustainability action plans (strategies) might play out in the future (if implemented).	Anticipate, foresight, envision, craft, analyze, and evaluate long-term future consequences, scenarios (multiple futures), and visions regarding intergenerational equity, future generations, uncertainty, etc.(Withycombe, 2010; Gardiner and Rieckmann, 2015; Ojala, 2017)
Values-Thinking Competence	Ability to identify, map, specify, negotiate, and apply sustainability values, principles, and goals: 1) to assess the sustainability of current and/or future states of complex systems; and 2) to construct sustainability visions for these systems; (3) to assess the sustainability of action plans (strategies) and interventions.	Identify, assess, negotiate, reconcile, reflect on, map, apply sustainability principles, morals, norms, ethics, goals, integrity, justice, conflicts, trade-offs, etc.(Remington-Doucette et al., 2014; Verma et al., 2016; Komasinkski and Ishimura, 2017)
Strategies-Thinking Competence	Ability to construct and test viable strategies (action plans) for interventions, transitions, and transformations toward sustainability.	Design, create, develop, test transformative, innovative, viable, feasible interventions, transitions, strategies, action plans, solutions, etc. considering barriers, inertia, path dependence, carriers, assets, etc.(de Haan, 2006; Wesselink et al., 2015; Fukushima et al., 2017)
Implemen-tation Competence	Ability to put sustainability strategies (action plans) into action, including implementation, adaptation, transfer and scaling, in effective and efficient ways.	Implement, enact, adapt, manage, transfer, scale action plans, strategies, change plans, intervention plans, governance initiatives, etc.(de Haan, 2006; Perez Salgado et al., 2018; Schank and Rieckmann, 2019)
Inter-personal Competence	Ability 1) to collaborate successfully in inter-disciplinary and -professional teams; and 2) to involve diverse stakeholders, in meaningful and effective ways, in advancing sustainability transformations.	Enable, motivate, facilitate interdisciplinary, transdisciplinary, cross-cultural collaboration in teams and among stakeholders through listening, compassionate communication, negotiation, conflict resolution, empathic leadership, etc.(Ulrich, 2016; Brundiers and Wiek, 2017; Sarpin et al., 2018)
Intra-personal Competence	Ability to avoid personal health challenges and burnout in advancing sustainability transformations through resilience-oriented self-care (awareness and self-regulation)	Reflect, motivate, have respect for, be responsible, be empathetic, self-care for identity, commitment, feelings, burnout, personal boundaries, limits of capacity, etc.(Glasser, 2016; Lozano et al., 2017; Giangrande et al., 2019)
Integration Competence	Ability to apply collective problem-solving procedures to complex sustainability problems: 1) to develop viable sustainability strategies (action plans); and 2) successfully implement them, in collaborative and self-caring ways.	Develop, apply, promote, make decisions to advance sustainability by using viable, equitable, and inclusive solution processes, procedures, frameworks, schemes, etc.(Jegstad and Sinnes, 2015; Hull et al., 2016; Wiek et al., 2016)

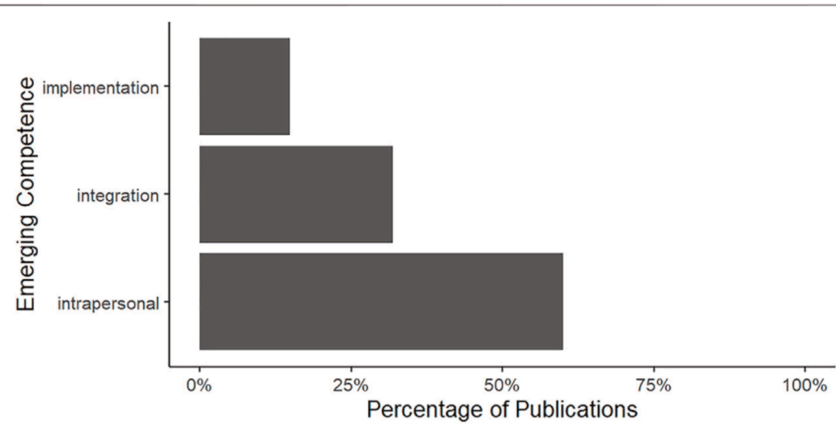

FIGURE 5 | Percentage of sampled publications (n = 272) that can be mapped onto the three emerging competencies (1997–2020).

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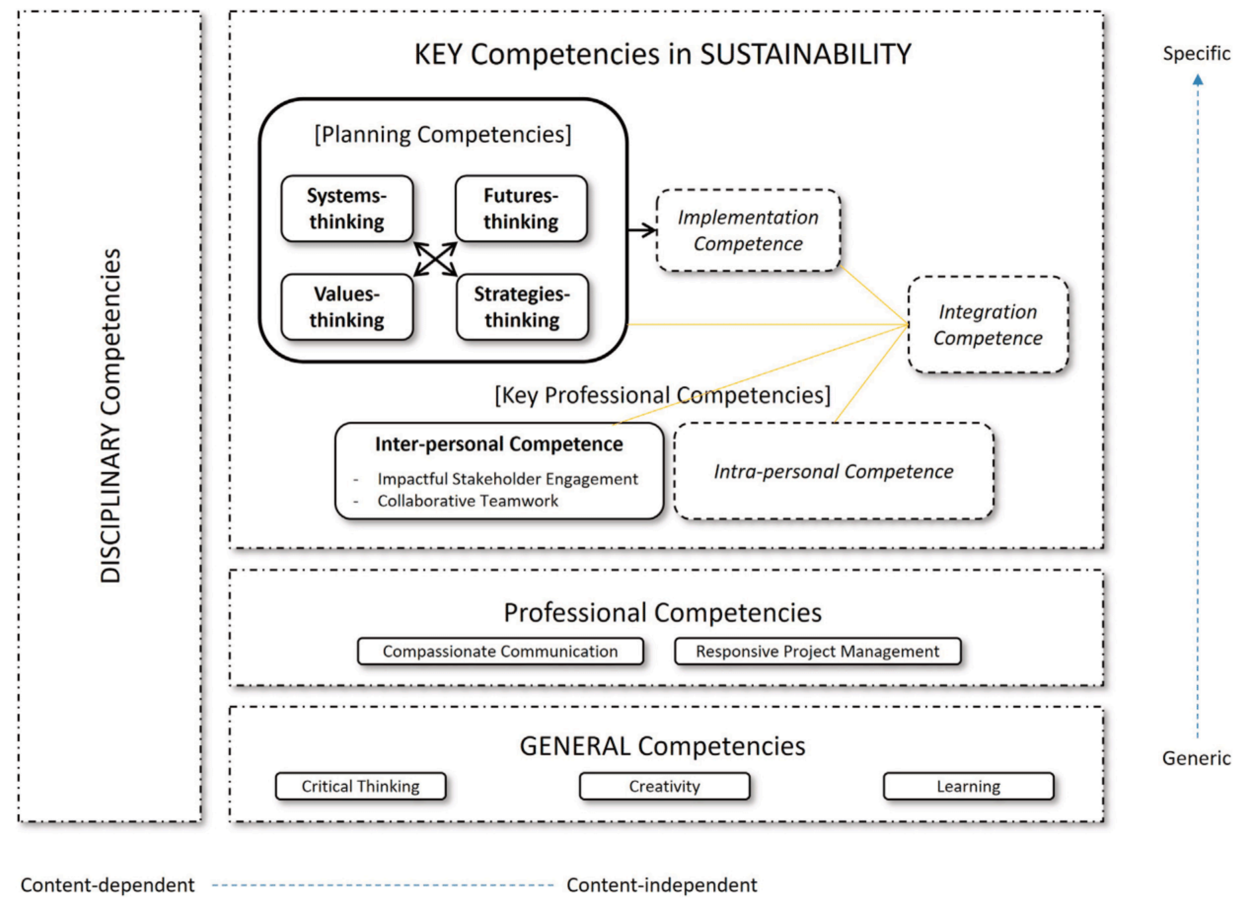

FIGURE 6 | Unified framework of competencies for advancing sustainability transformations; centered on 8 key competencies in sustainability with 5 established (bold) and 3 emerging (italic); and complemented by disciplinary, general, and other professional competencies.

Disciplinary competence: There is broad agreement that advancing sustainability transformations requires content-dependent competencies, e.g., on climate, water, energy, food, and international development (Dale and Newman, 2005; Demssie et al., 2019). Disciplinary specialties will be critical complements to the content-independent sustainability competencies, resulting in "t-", "pi" or "shield" shaped professional profiles (Uhlenbrook and de Jong, 2012; Conley et al., 2017; Pennington et al., 2020).

General: Although there are no universally agreed-upon general competencies, Binkley et al. (2012) distilled a broad sample of literature into a set of ten so-called "21st century skills". Three of these general competencies were also frequently mentioned in the literature reviewed in the present study and can therefore be considered important complementary general competencies for advancing sustainability transformations, namely, the abilities of critical thinking, creativity, and learning.

Professional Competencies: As indicated above, inter- and intra-personal competencies are considered key competencies in sustainability, shared mostly with other caring professions, e.g., medicine, nursing, social work. In addition, two other, more "regular", professional competencies, namely (advanced) compassionate communication and responsive project management, are important for advancing sustainability transformations on a more basic level (MacDonald and Shriberg, 2016; Brundiers and Wiek, 2017; Lozano et al., 2017).

DISCUSSION

This systematic review of the growing body of literature found, despite appearance to the contrary, a convergence on learning objectives in sustainability education around a discrete set of key competencies. In particular, the five key competencies described through a framework in 2011 (Wiek et al., 2011), namely, systems-thinking, anticipatory, normative, strategic, and interpersonal competence, have gained widespread use. Several productive propositions have emerged as well. Integrating the advances of the last decade, a framework of eight key competencies in sustainability is described, along with three classes of complementary competencies which form the best published scholarly knowledge of how to equip sustainability change agents to advance sustainability transformations. While this study focused on the

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perspectives captured in the literature, reviews of university sustainability programs (Trencher et al., 2018; Salovaara et al., 2020) and expert surveys (Rieckmann, 2012; Demssie et al., 2019; Brundiers et al., 2021) largely align with the findings presented here.

Zooming into the review results, systems thinking is the most established of the planning competencies, followed by interpersonal competence, which is addressed in many project-based sustainability courses (Konrad et al., 2020) (**Figure 4**). However, these are the less transformative of the key competencies. Futures-, values-, and strategies-thinking competencies, so far established to a lesser extent, are critical for change that disrupts the status quo (Hsu, 2020). These competencies enable graduates and professionals to envision sustainable futures, based on the SDGs, and develop effective and efficient strategies (action plans) to achieve them.

Beyond this, the three emerging competencies are much more unconventional, if not controversial. First, the aspects included as intrapersonal competence (self-awareness and self-care) are not part of typical learning objectives (Shephard, 2008; Frank, 2021), and do not fit well with how competencies are generally defined (Shephard et al., 2019; Gómez-Olmedo et al., 2020). Yet, this points more to a broader issue in education: medical schools, for example, having long realized they need to address emotional, and not just intellectual development in students (Coombs and Virshup, 1994). Second, while addressing sustainability problems is a common theme in sustainability education at the university level (Brundiers et al., 2010), this does not usually mean fully preparing graduates for *doing* sustainability (Alvarez and Rogers, 2006). Implementation competence calls for that to change, yet, this is a largely unexplored space for university programs. Finally, this review showed that like other scientists, those in sustainability continue to dissect holistic processes (i.e., problem-solving), into constituent parts (i.e., lists of competencies, as in (Lozano et al., 2017)). Integration competence pushes against this tendency and urges an emphasis on educating for the connections between competencies.

Sustainability science has developed and adopted a variety of approaches to solving problems (Angelstam et al., 2013; Polk, 2014; Wiek and Lang, 2016; Henry, 2018), with initial attempts to explore how that can shape education (Wei et al., 2020). The unified framework centers on how professionals can best collectively engage in sustainability problem solving and advancing sustainability transformations. Through this foundation, the framework is explicitly *not* intended to serve any specific discipline but should be adoptable by *all* disciplines and fields (with some relevance to sustainability). The framework offers a base from which to build off and specify learning objectives in life science, engineering, business, or teacher's education, to name a few. To this end, the language of the unified framework has been further universalized (e.g., "normative" is often mistranslated), and discilenary competencies are now situated within this more extended framework.

The reviewed literature focused on publications in English, which underrepresents large regions of the world; a problem confirmed in other studies (Weiss and Barth, 2019). Indeed, there is, for example, a growing discourse in Latin America (in Spanish) around how to develop sustainability education (Dieleman and Juarez-Najera, 2008). We found that specifically with regards to learning objectives in sustainability little has been published (in English) by researchers from outside the OECD. After many early calls for it (Mochizuki and Fadeeva, 2010), publications from underrepresented countries have recently increased (23 of 25 identified were published in the last 5 years), but more comprehensive inclusion of these perspectives is needed.

CONCLUSIONS

The results of this study show that, despite terminological differences, there is substantive convergence in the literature on what change agents need to be capable of to advance social transformations to sustainability. On this basis, the article describes a framework of eight key competencies in sustainability, broadly applicable to sustainability education in all disciplines. The unified framework of key competencies in sustainability links science, education, and society in the joint effort of broadening and accelerating transformations towards the Sustainable Development Goals. This does not mark the endpoint of needed research, rather an opportunity to make much needed advances. Three immediate needs include: 1) research and development of the emerging competencies; 2) operationalization of the framework across disciplines, learning settings, and global contexts; and 3) testing the framework in real-world problem-solving settings. Even more fundamental though is the need for the community of scholars to come together and better coordinate their efforts. Complementary and comparative studies would overcome the current fractured structure of the field and allow for more robust and accelerated advances.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

AR and AW designed the research project together and structured the article and wrote the article together. AW secured the funding, and AR did the data collection and full literature review. Both authors approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2021.785163/full#supplementary-material

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IRA: The Incentive Re-activation Act?

By Larry Eighmy and James Hayes

November 2023

The IRA, according to the Bipartisan Policy Center, hopes to accelerate the downward trajectory of US greenhouse gas emissions toward Paris Climate commitment goals. The law provides benefits for residential and commercial buildings as well as the production of renewable energy. This article focuses on commercial buildings. The side bar provides input on residential incentives and production tax credits.

The Inflation Reduction Act refreshes, expands and changes the calculations for existing renewable and energy efficiency incentives and adds new ones. This, coupled with macro decarbonization pressures such as rising energy prices and growing interest in Environment, Social, and Governance factors, has created an new and increasingly favorable environment for efficiency projects, electrification, and climate action planning.

For context:

> One of the most striking and clear aspects of the IRA is the Direct Pay provision for the Investment Tax Credit (ITC). Previously, non-profits could not benefit from tax credits unless a for-profit project developer provided construction capital and sold the non-profit partner (off taker) electricity generated from the PV array. These so-called Power Purchase Agreements (PPA's) allowed non-profits to realize about half the ITC's potential value by reducing the effective value of the monetized credit, raising the cost of funds, undervaluing the Solar Renewable Energy Certificate (SREC's) and adding legal costs.
>
> The new law has incentive multipliers based on demographic and geographic parameters but for small projects (for example, under 1 MW for solar) the multipliers are automatically granted and the provision for prevailing wage and apprentice programs also exempted. For other components additional guidance continues to evolve.
>
> The IRA expands the eligible Energy Property beyond just solar photovoltaic projects to include building scale wind like vertical axis systems, biogas, ground source heat pumps, geothermal electricity, micro-grid controllers, fuel cells, waste energy recovery, energy storage, electrochromic glass and electrical infrastructure associated with a PV array. Prior to the law, the Investment Tax Credit (ITC) just applied to solar and was being phased out.

The Energy Policy Act of 1986 (EPAct) predated the ITC's which were originally part of the ARRA of 2009. And while important they were harder to use because the incentive came as a tax deduction and was effectively restricted to large commercial buildings and municipal buildings. The IRA enhancement allows for the "project designer" to receive the benefit of the deduction regardless of the ownership or tax status of the building. The deductions can now also be unlocked through alternative pathways which are simpler and more timely. In addition, the baseline to compare is 2007 (for the next 4 years and then it will adopt the 2019 ASHRAE code) which is much less stringent than current energy code and means most buildings will meet the 25% savings threshold.

Let's examine several case studies:

Solar PV for a not for profit school

The first is a solar array less than 1 MW on an independent school campus. In the past, a Special Project Entity (SPE) that included the investor, the firm with a tax appetite and the developer, would have to be established and the agreement would have to be negotiated with the school who was referred to as the off taker. In our experience the cost of the legal representation for negotiating the PPA was frequently more than the first several years savings. And on top of that the demand for the tax appetite effectively discounted the incentive by 20-30%. In addition, because the financing was to a SPE the cost of funds was typically much higher than the cost of funds for the host institution because there was only recourse to the array and no direct financial collateral from the investor or the school. In addition, the entire SREC would benefit the SPE. Given the uncertainty of the length and strength of this market the value was typically underestimated and the school could not claim the renewable attribute as a reduction to its GHG inventory. The IRA allows the school to invest directly, receive the entire value undiscounted (and now back to 30% ITC) and to finance it at rates that are lower than the SPE's. The school will also be able to monetize the SREC's early in the project to help pay down the loan and then decide whether to swap or claim the SREC's at a later time. In our case study the levelized cost of energy from the PV array is likely 30% lower (it will depend on local net metering rules and utility tariffs) than the recently inflated price of grid power. This spread means that even if there is uncertainty about future markets a hedge makes sense as a financial strategy and in our experience when the project helps financial and environmental sustainability there is call to action and the intent of the IRA is achieved.

Electrification is an important tool for the reduction of greenhouse gasses and as such the provision of the IRA expands incentives related to 'interconnection property costs" such as micro grids, electrical infrastructure such as transformers and distribution panels, switchgear and even batteries that are not powered from the solar array. This can be beneficial for reducing emergency generators and peak shaving and is a new IRA provision. So in the case study above the school is also considering an electrical upgrade to tie in solar, provide power for future electrification and replace major deferred electrical infrastructure. This scope is now included in the IRA incentives and in our case study above is 30% of $1M for an additional $300,000 savings. This shift will change the typical configuration of emergency power systems to become more centralized and battery dependent as opposed to fossil fuel driven emergency generators.

For the for-profit building owner the program returns the ITC to 30% and adds a series of additional adders based on demographics and location. The law also allows for continued accelerated depreciation for for-profits that is calculated as the full tax basis minus 50% of the ITC over a 5 year basis.

Upgraded HVAC

Let's now assume we have a campus with an old steam distribution system or a new building with ground source heat pumps. As long as 75% of the energy being used is coming from these sources the entire project including all of the piping and terminal units will be eligible "energy property" under the IRA and will receive the 30% ITC. And of course it can benefit a not for profit through the Direct Pay provision.

Large Scale Buildings

All of the above incentives are based upon tax credits that can be used by a for profit, sold by a REIT that might not have a tax appetite, or received as a Direct Payment by a not for profit. The IRA, however, also reenergized the EPAct 179D by extending it and strengthening it. These are tax deductions, not tax credits, so to calculate the incentive you have to take the deduction times the effective tax rate so let's assume 20% of the deduction is monetized. The Summary provisions include:

> $.50-$5.00 per square foot depending on prevailing wage, apprenticeship program and level of savings. The minimum saving is 25% compared to 2007 standards until the end of 2026 in which case the standard changes to the 2019. This low standard for the next 3 years means that most buildings will qualify as current energy code for most jurisdictions is more than 25% better than the 2007 standard.
>
> There are also two alternative pathways that did not exist prior to the IRA. These are a pathway for retrofits that reduces the EUI by at least 25% or a building modeling or simulation program that also shows a minimum 25% reduction.
>
> Like the Direct Pay provision for non for profits for the ITC, the EPAct deduction now can be effectively used by the not for profit by transferring the benefit to the "Designer". Previously this was just allowed for municipal buildings.

So with these as context let's look at two examples:

In the first we have a large 1 million square foot warehouse that is LEED certified and was built with prevailing wage and an apprenticeship program. An energy model is a prerequisite for LEED and it would just have to be rerun against the 2007 baseline. It would be eligible for $5/sf or $5M deduction or about $1M in value to the owner.

In the second we have a 2 million square foot campus and with a strong commitment to reach climate neutral that is developing a comprehensive retrofit project that includes that converting a natural gas driven steam system to biogas to geothermal, electrification of some buildings not on the central distribution system and implemented findings from an energy audit that reduces campus EUI by at least 25%. Let's assume that the prevailing wage requirements were not met the value of the deduction would be $500,000 or $100,000 in monetized value.

Summary

The IRA can provide tremendous benefits that help accelerate the transition from carbon intensive to lower carbon options and less energy. Previously, state and utility incentives provided some help but they were ephemeral. In this case the local incentives and Federal credit and deductions can all be stacked.

Part of the promise of the IRA is it's longevity. As Bill McDonough likes to say, "sustainability takes for ever and that is the point." The IRA provides long term incentives that over time will be easier to understand. Right now, we just need to understand that the Incentive Re-Activation Act provides a new lens upon which to view energy related projects whether they be for a new building, retrofits or infrastructure.

As a disclaimer, the IRA is packed with a myriad of phase in and phase out rules, project scale parameters and added provisions that can expand the ITC beyond the 30% in some cases. This white paper is designed to provide context and offer strategies for maximizing the incentives. New guidance appears regularly. For example, a recent interpretation on EV credits was issued on April 20 that expanded the applicability of credits. It is best, however, to understand the strength of the IRA and then engage a specialist to examine the options at the conceptual stage to see if the IRA might change the basis of design. It is our experience that suggests that the best financial and or environmental solution may require a different engineering approach. For this reason the IRA really is transformative.

Side Bar

The focus of the white paper is on commercial and not for profit buildings. Yet the IRA also provides significant benefits for owners of residential real estate and there is a very simple calculator found at www.rewiringamerica.org. For renewable generation, the incentives are referred to as Production Tax Credits and rather than being a one time discount they are based on credits that flow for 10 years based on production. In general, it will be difficult to take advantages of both ITC and PTC but like Donor Friendly PPA's there could be an opportunity, given the length of time that the IRA covers to embrace the ITC first and then after the recapture period sell to an SPE for a PTC? Far fetched, maybe a new reality just like the IRA provides an incentive for a new EV and another incentive for the same used EV!

Larry Eighmy is Managing Principal and James Hayes is Associate Principal of the Stone House Group which is a firm which specializes in developing energy and sustainability strategies that are implementable. The IRA provides incentives to improve environmental, building and financial stewardship.

Maria Rodale Become a fan
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How Schools Can Reduce Energy Costs and Promote a Sustainable Future

Posted: 08/03/2015 12:03 pm EDT | Updated: 08/10/2015 11:59 am EDT

Part III of a three-part sustainability series by guest blogger Larry Eighmy, Managing Principal of The Stone House Group

When you think back on your education, what experiences had the most impact on you? Many would cite team projects, fieldwork, and hands-on learning experiences as their strongest memories. Personally, my 8th-grade camping trip helped me retain more information about the environment than any previous classroom lecture ever did.

All educational institutions share the goal of preparing their students for the future--but can they achieve this goal while they simultaneously compromise that future by harming the environment? I believe schools have an obligation to protect and enhance the world they're preparing their students for by being good stewards of the environment--and that the steps to get there aren't as difficult or expensive as many seem to think.

In the United States, buildings alone consume 41 percent of our total energy, 65 percent of our electricity, and 5 billion gallons of potable water per day. School buildings are some of the biggest consumers. And while some schools are jumping on the sustainability bandwagon (for example, Dickinson College has pledged to be completely carbon neutral by 2020 and has been named America's 3rd Greenest College by Sierra magazine), others are much farther behind.

Furthermore, many school administrators are completely unaware of these buildings' energy use intensity (the amount of electricity, gas, and oil they consume each month per square foot) or how large their carbon footprint is. Schools often shy away from actions that could make them more environmentally conscious--like energy audits--due to the upfront cost of these services. However, in reality, there's a resource schools already have that could help them lower their energy usage: their students.

How can students help schools reduce energy costs and emissions while also learning about sustainability? Through a method called project-based learning.

Project- or problem-based learning (PBL) is an educational model that organizes learning around projects or solving a problem. PBL moves away from traditional single-subject silos and rote memorization and instead focuses more on collaboration, interdisciplinary work, creativity, and real-world problem solving. In PBL, teachers act more as facilitators than instructors and guide students to learn concepts and solve problems on their own rather than telling them how to.

The incorporation of PBL into school curricula represents a major shift in America's education system, a system that has not significantly changed since it was designed in 1893 (the 2015 Sundance Selection film Most Likely to Succeed explores this idea in depth). Back then, students entering the workforce had to possess a set of standardized skills to easily integrate into America's growing industrial economy. Today, technologies can perform many previously human-powered jobs, and the Internet has lessened the need for rote memorization. America's top companies now prefer to hire innovative, collaborative, and problem-solving individuals with PBL experience over those with perfect GPAs and SAT scores. In a 2014 *New York Times* article titled "How to Get a Job at Google," Thomas L. Friedman summarizes Laszlo Bock's approach to hiring at Google, stating, "Beware. Your degree is not a proxy for your ability to do any job. The world only cares about--and pays off on--what you can do with what you know (and doesn't care about how you learned it)."

By infusing PBL with sustainability, educational institutions can work toward reducing their carbon footprint while helping prepare students to build a sustainable economy. Through PBL, educators can give students hands-on learning experience, train them to evaluate environmental issues directly related to the school, and simultaneously track the school's environmental impact. Students can perform energy audits and greenhouse gas accounting and contribute to climate action plans--helping their schools become more environmentally conscious at a lower cost than if these services were outsourced.

My firm has seen the effectiveness of sustainability-infused PBL in action by partnering with several of our education clients, including Broughal Middle School, in a Keystone Energy Efficiency Alliance award-winning program called "LEED for Gingerbread Homes." We wanted to inform the students about LEED and green-building strategies outside of a traditional classroom approach, and Broughal's building was certified LEED Gold.

Students were provided with a limited amount of gingerbread house materials (cookies, candies, icing, and such) and a list of LEED credits that they could attempt in the design of their gingerbread house. Working in teams of five, they were given an afternoon to design and strategically choose which green building strategies they would incorporate into the design. The houses were then judged and scored by green building professionals and community members. By the end of the program, the students had learned what the LEED plaque on their school's wall meant and gained experience working in a team of their peers, and they were visibly abuzz with excitement and accomplishment over what they had just achieved.



The gingerbread LEED houses.

PBL shouldn't stop at the primary school level. In fact, I've seen just how effective college-level PBL is in producing independent, innovative, and successful workers in my own firm, as several of my associates participated in the U.S. Department of Energy's Solar Decathlon with collegiate teams. Sustainability-minded PBL can also be implemented outside of educational institutions. Homes, office buildings, and other campuses encompass our daily lives and contribute significantly to our carbon footprint. These buildings should be used as laboratories for learning and innovation at all ages.

Through project-based learning, our nation can easily become more environmentally aware and prepare for the transition to a carbon-free economy.

Larry Eighmy is the managing principal of The Stone House Group, which helps clients find the overlap between financial and environmental sustainability through energy management, climate action plans, facilities management, and sustainable design services. The company has served more than 250 clients, from Pennsylvania's Lehigh Valley to the Caribbean and the Far East. The company practices what it advocates, as evidenced by its development of a Zero Carbon Neighborhood at the Flat Iron in South Bethlehem, Pennsylvania, where the company is headquartered.

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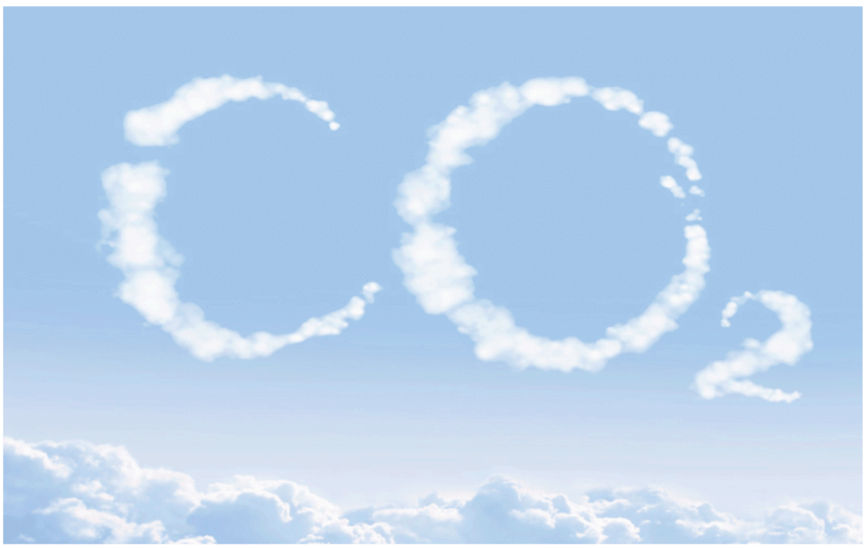
Three Things You Need to Know About Carbon

Posted: 08/03/2015 1:00 pm EDT | Updated: 08/03/2015 1:00 pm EDT



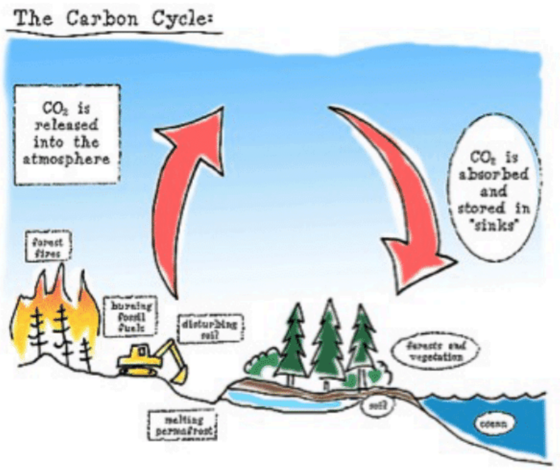
Part II of a three-part sustainability series by guest blogger Larry Eighmy, managing principal of The Stone House Group

You may recall learning about the carbon cycle in your school days, but did you know that understanding this cycle is imperative to understanding climate change and sustainability?

You can think of carbon dioxide as the common currency used to determine our impact on the environment. The gas is an important factor to achieving long-term sustainability that we all need to consider.

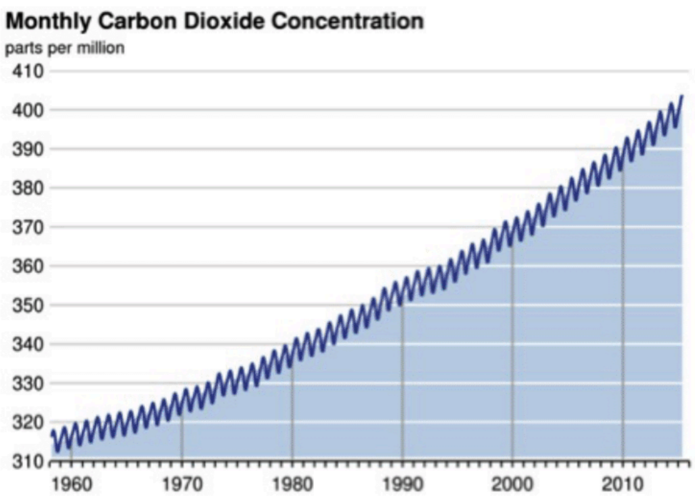
Here are the three things you need to know about carbon dioxide and climate change:

1. Carbon is concrete and can be measured. Carbon dioxide (CO2) is naturally present in the earth's atmosphere and is essential for the existence of life on Earth. CO2 is constantly being transferred between animals, plants, the ocean, the atmosphere, and the soil in a naturally occurring and self-sustaining cycle. CO2 and other greenhouse gases (GHGs) in Earth's atmosphere produce the greenhouse effect, where these gases protect Earth from dangerous solar radiation and keep the planet at a habitable temperature. All gases, including water vapor, can impact the cycle and are all measured in terms of CO2 equivalents (CO2 e's). The Kyoto Protocol, an international agreement that committed 192 parties to reducing man-made greenhouse-gas emissions, defined the most significant greenhouse gases and their associated global warming potential, which paved the way for benchmarking and tracking carbon impact.



Source: National Center On Universal Design for Learning

2. Carbon levels are rising. Concentrations of CO_2 and greenhouse gases in the atmosphere are now being amplified by the fossil fuels and petrochemicals we use every day in our industrialized society. Proof of this amplification can be seen in the Keeling Curve (shown below). The curve reflects the work of Charles David Keeling, PhD, a professor at Scripps Institution of Oceanography, who, starting in 1958, took monthly measurements of the CO_2 concentrations at Mauna Loa Observatory in Hawaii. Keeling's work, along with ice core data that tracked CO_2 concentrations from as far back as 800,000 years ago, shows that CO_2 levels are rising at a dramatic rate and are approaching concentrations that have not been seen on Earth for millions of years.



Source: The Scripps Institute of Oceanography

3. Monitoring and reducing carbon usage saves money, in addition to making us better global citizens. As individuals, we can track our carbon footprint (much as we track our activity level with fitness trackers) through our energy and water bills, our gas bills for cars and lawn mowers, and the pesticides we use on our plants. Free online tools exist to help estimate your carbon footprint, such as The Earth Day Network Footprint Calculator. Companies are also starting to track CO_2 associated with their enterprises. In many ways, these actions measure embodied energy--the sum of energy required for the mining, manufacture, and transport of materials to a building site. Some of these actions have been codified. For instance, as part of its LEED building certification program, the U.S. Green Building Council provides a credit for builders utilizing material that is sustainably grown, is recycled, or is local.

Similarly, there is a concept popularized by sustainably minded architect William McDonough called Cradle-to-Cradle that says we must account for the energy used in the entire life cycle of a product. Because of pressure from their customers and shareholders, corporations and institutions create Climate Pledges to commit to reducing their carbon footprints, or Climate Action Plans to focus on strategic management and cost-effective reductions of CO_2 emissions. These are all proxies for lower embodied energy

As the famous quote usually attributed to management consultant Peter Drucker states, "What can be measured can be managed." It follows that by measuring, we can manage our CO_2 emissions. The process begins with the seemingly small step of reviewing the carbon cycle we learned in 6th-grade Earth Science.

Once they understand the cycle, individuals and corporations alike can understand their contribution to it and start to make changes to reduce their footprint. Small changes will become bigger, and eventually our society can go from walking to running toward sustainability.

As William McDonough likes to say, "Sustainability takes forever, and that is the point." It will be a continuous habit, encouraged by measurement, which will soon become second nature to the human race. By understanding our carbon impact we will make more informed decisions and eventually prove to Kermit the Frog that it IS easy being green!

Larry Eighmy is the managing principal of The Stone House Group, which helps clients find the overlap between financial and environmental sustainability through energy management, climate action plans, facilities management, and sustainable design services. The company has served more than 250 clients, from Pennsylvania's Lehigh Valley to the Caribbean and the Far East. The company practices what it advocates, as evidenced by its development of a Zero Carbon Neighborhood at the Flat Iron in South Bethlehem, Pennsylvania, where the company is headquartered.

For more from Maria Rodale, visit www.mariasfarmcountrykitchen.com

Follow Maria Rodale on Twitter: www.twitter.com/farmkitchenblog

MORE: Carbon Carbon and Climate Change Climate Change Co2 Carbon Dioxide Sustainability Leed Cradle to Cradle Carbon Cycle William McDonough Larry Eighmy The Stone House Group Maria Rodale Maria's Farm Country Kitchen

Conversations

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Sustainable Energy Fund

The Stone House Group

PROSPECT14

Established in 2017 and based out of Montgomery County, Pennsylvania, Prospect14 brings national expertise in renewable energy development. **Our team offers over 70 years of combined experience, having collaborated on more than 5 GW of renewable energy projects, equivalent to the output of 15 average coal-fired power plants**. Committed to advancing U.S. energy goals through collaborative partnerships, Prospect14 works with stakeholders and supports landowner interests.

Prospect14 works on distributed generation projects ranging from 5 MW to 20 MW across Pennsylvania and Maryland. With a diverse portfolio of brownfield and greenfield projects across 7 markets, and 200+ we are well-positioned to develop projects effectively, at high-volume to support the build out local renewable energy generation.

What is Distributed Generation?

Distributed generation refers to a variety of technologies that generate electricity at or near where it will be used, such as solar panels and are typically connected into the electricity grid at the distribution level.

The deployment of more local, renewable technologies offer a lot of great benefits, the most front facing being **energy security, resiliency, and emissions reductions.** Distributed generation reduces or eliminates the wasted energy that happens during transmission and distribution in the electricity delivery system, **ultimately saving the customer money**. Your electric bill shows how much of the bill is from “Transmission & Distribution.” in some utility territories in Pennsylvania, this accounts for 50% of your electric bill.

How can I support the deployment of solar energy projects?

Be an advocate for solar development in Pennsylvania!

In order for our energy generation resources to include renewables in the mix, policy is required to reinforce reliability and security of Pennsylvania’s solar future. One of the only programs that already exists in Pennsylvania, and support the development of our projects is the Net Energy Metering Program.

Call your state house and senate representative and tell them you support the net energy metering program ~~and~~ want a community solar program in Pennsylvania!

Pennsylvania doesn’t have a community solar bill, but a community solar bill (HB 1155) has been introduced into the 2025-2026 legislative session! Community solar would help counter rising electricity prices, enhance grid resilience and provide the opportunity for Pennsylvanian’s to participate in the cost-saving benefits of solar without installing their own systems.

What can 6 MW do?

Power 1,008 homes

of clean energy generated locally, per year

Generate 12,876 MW

of clean energy generated locally, per year

An **average U.S. home uses 10.668 MWh** of electricity annually

Generate $500,000 - $1.6 Million

of tax revenues to the county & school district over the project life

Generate $1-5 Million

in revenue for the landowner(s) over the life of the project, providing significant financial opportunities to Pennsylvanians

Avoid 7,872 Metric Tons of CO2

releasing into the atmosphere. Which is equivalent to consuming

885,714 gallons of gasoline, burning 8,743,584 pounds of coal

Energy is the biggest emitter of GHGs

Energy is essential for our homes, hospitals, schools, manufacturing industries, commercial industries and transportation. The global community relies heavily on energy to sustain its economic growth and development.

As the world population continues to grow so does the demand of energy

72.3% of global GHG emissions come from Energy

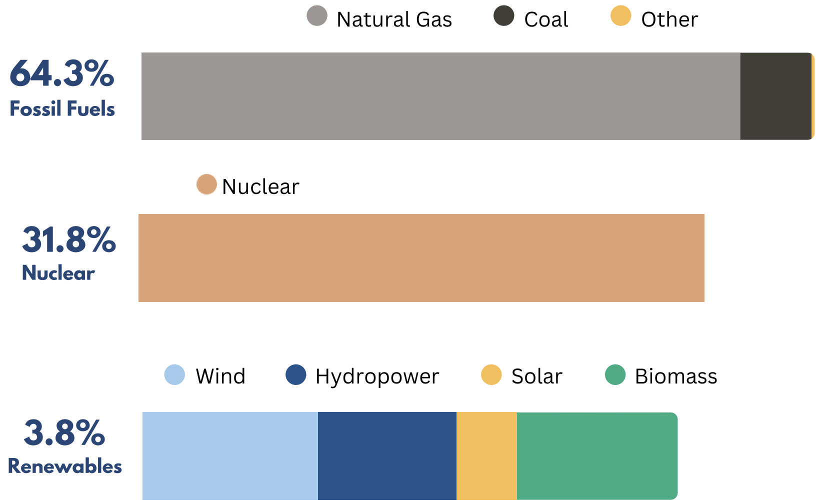
What does energy look like?

According to the U.S. Energy Information Administration (EIA), the resource equivalent of 1 kWh of electricity is:

1.12 pounds of Coal per kWh
7.36 cubic feet of Natural Gas per kWh
0.08 gallons of Petroleum liquids per kWh

1 Solar Panel can generate 2 kWh per day under full sun
1 Wind Turbine can generate 8,573,631 kWh per year
A 582 MW capacity Nuclear Power Plant operating at full capacity will generate 13,968 megawatt-hours (MWh) in 24 hours
Niagara Falls has the capacity to output ~ 4.9 million kilowatts per year

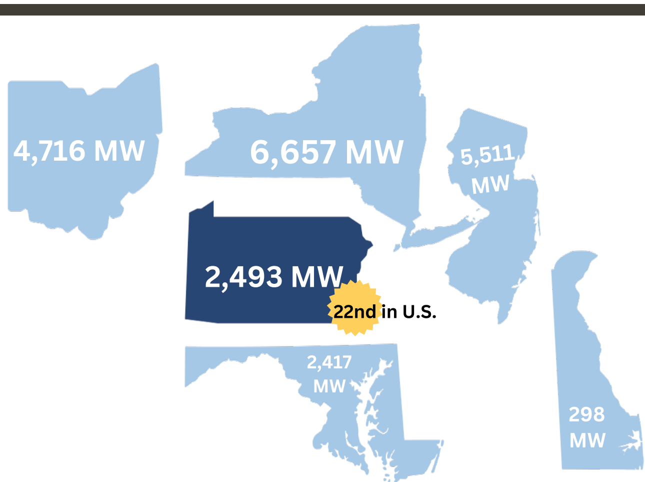
What makes up Pennsylvania's energy?



The deployment of distributed generation projects also improves the stability and reliability of our electricity grid through interconnection upgrades that are required ahead of project constriction and are paid by the developer. This means that the **cost of grid upgrades does not fall to the customer.** When the utility upgrades grid infrastructure, they recover the affiliated costs from the rate payer, resulting in higher electricity rates for customers.

How does solar in Pennsylvania compare to neighboring states?

We got some work to do!



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BY LAWRENCE EIGHMY
THE STONE HOUSE GROUP

10 STEPS TO A SUCCESSFUL ENERGY MANAGEMENT PROGRAM

In recent years, many independent schools have struggled to reconcile energy budgets with actual energy costs. With variables such as commodity costs, consumption and weather at play, it can be difficult to predict institutional energy usage or hold staff accountable for budget overages. However, there are "tried and true" strategies that schools can implement to manage and reduce energy costs.

Low energy consumption obviously has a direct impact on energy cost, but at a deeper level, good energy performers typically have efficiently managed facilities and low levels of deferred maintenance. In examining best practices for facilities management at boarding school campuses in the northeast, The Stone House Group received a suggestion from John Tuke, CFO at The Hotchkiss School, to assemble a list of our most successful energy management strategies. Some of the strategies that follow are taken directly from our work with Hotchkiss, where we have served as energy manager and advisor since 2001.

1. CONNECT SUSTAINABILITY AND MISSION

When a school's mission includes environmental stewardship, its facilities become part of the learning environment. The Hotchkiss School's mission statement expresses hope that "graduates will leave Hotchkiss with a commitment to service to others and to environmental stewardship, and with greater understanding of themselves and of their responsibilities in a global society."

In practice, The Hotchkiss School differentiates itself from many other independent schools by thinking strategically about sustainability. In 2011, we helped the school develop a "Climate Action Plan" to establish greenhouse gas emissions targets and the goal of eventually achieving net climate neutrality, or the point where all carbon emissions are reduced through, or offset by, renewables. The foundation of this plan already existed in the school's Energy Management Program. Combined, this commitment to environmental stewardship helps ensure that the school's students live and learn on a campus that helps to prepare them for a bright future. (Hotchkiss in many ways is following the American College and University Presidents' Climate Commitment, which provides a template for moving toward climate neutrality.)

The Hotchkiss School, in Lakeville, Conn., sits on an 827-acre campus in an area designated by The Nature Conservancy as one of 200 "Last Great Places."

2. UNDERSTAND THE 3 Cs OF YOUR CAMPUS

As Peter Drucker famously said, "If you can't measure it, you can't manage it." We recommend that independent schools maintain an energy database that tracks the "3 Cs" of their campus: energy **C**onsumption, energy **C**ost and **C**arbon emissions. At The Hotchkiss School, our early energy databases tracked electricity and fossil fuels for monthly and annual variations in cost and consumption. As concern grew over greenhouse gas emissions, this effort was extended to understanding how much of the school's carbon footprint can be attributed to energy consumption.

Energy databases that factor in weather data, calculate month-to-month comparisons and identify changes in year-to-year trends help independent school business officers and facilities managers better understand how their campus consumes energy. Advanced campuses install sub-metering equipment to capture consumption and cost data for individual buildings, and hold monthly meetings with the designated campus energy manager. Consumption anomalies should prompt a closer look at equipment operation and scheduling; cost anomalies should prompt an understanding of changes in utility tariffs and rate structures (i.e., increased penalties for peak electric demand).

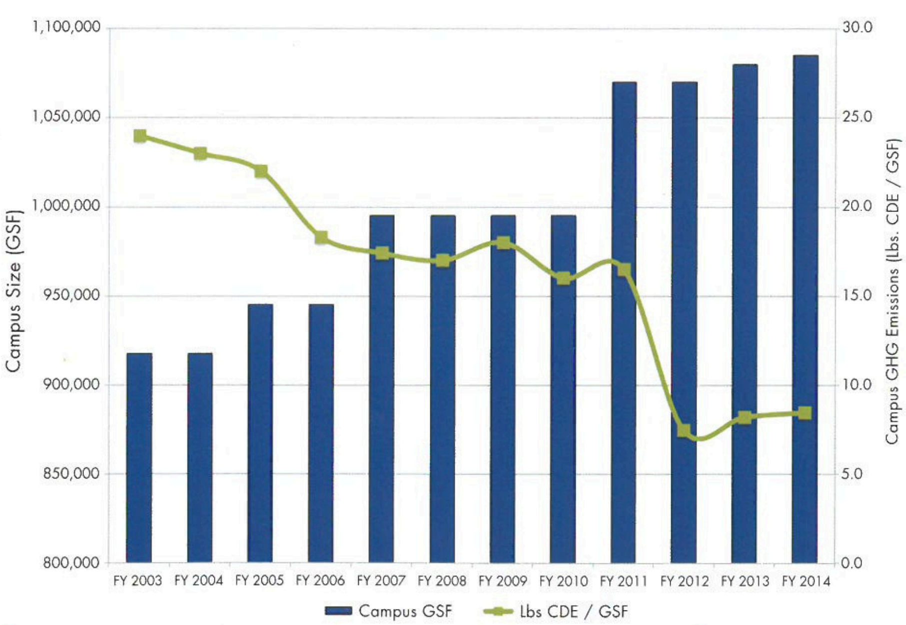
3. DEVELOP A COMPREHENSIVE PROCUREMENT STRATEGY

Most states now have deregulated utility environments, prompting many independent schools to take advantage of the option to purchase electricity and natural gas from third-party suppliers, as well as to explore methods such as aggregating with other institutions, partnering with brokers and issuing RFPs for pricing. At this time, we believe the most effective energy procurement

TOTAL ENERGY COST =
ENERGY UNIT COST X ENERGY CONSUMPTION

ELECTRIC TOTAL $ =
$ PER KILOWATT-HOUR (KWH) X TOTAL KWH CONSUMED

NATURAL GAS TOTAL $ =
$ PER DEKATHERM (DTH) X TOTAL DTH CONSUMED



While The Hotchkiss School's campus size has increased since 2003, greenhouse gas emissions per gross square foot have decreased by more than 60 percent.

strategies involve hedging, identifying price floors and ceilings, and purchasing layers of energy needs through online reverse auctions.

A school's energy cost is determined by the formulas shown at the bottom of page 29.

By developing a procurement strategy, schools can control the "energy unit cost" variable. Energy markets have become extremely complex and volatile, similar to the stock market. Catastrophic events such as back-to-back Hurricanes Katrina and Rita drove gas pricing to 10-year highs, at almost $14/DTH. In April 2012, gas prices bottomed at around $2.80/DTH, but they spiked again in December 2013 to $5.90/DTH, an increase of 111 percent. Given this unpredictability, independent schools benefit from partnering with experts that deal with energy markets daily and understand market fundamentals that cause prices to fluctuate.

At Hotchkiss, The Stone House Group uses a third-party proprietary online reverse auction platform to track energy and ensure that the school is able to go to market when the conditions are favorable. The corollary is that the data are always available and measuring is easier. Today, the school's energy unit costs are below its previous rates. More importantly, future exposure is mitigated through layered purchases.

4. REDUCE HEATING AND COOLING LOADS WITH FACILITIES IMPROVEMENTS

By reducing its buildings' energy loads, a school can avoid using more energy than needed. New construction and deep-cutting renovations are optimal times to evaluate the energy required to operate facilities.

At independent schools, energy is primarily used for heating, cooling, lighting, ventilation, cooking and domestic water heating. These uses are intertwined, therefore changing one often impacts others. For a given building, the main drivers of heating and cooling loads are the building envelope (generally, exterior walls, windows and doors), ventilation and internal loads. Insulation levels, measured as an "R-value," indicate how much heat a building will gain (summer) or lose (winter). Ventilation requirements are dictated by the local building code and are based on the level of activity in a particular space; for instance, an aerobics studio will require more ventilation per person than an auditorium, but an auditorium will be more densely packed with people. Internal loads are typically things that give off heat inside a building, such as people, lighting, computers and cooking equipment.

Opportunities for load reduction abound and include improved insulation, higher-performance windows and lighting upgrades (see strategy 7 for more on end-use technologies). However accomplished, load reduction is a prudent investment because it generates persistent savings throughout the life of the facility.

Completed in 2011, Hotchkiss's centralized biomass boiler plant has saved the school approximately $300,000 a year. Its serpentine-shaped green roof captures more than half the storm water that falls on it, protecting nearby wetlands. Learn more at http://go.nboa.org/HotchkissBiomass.

5. DEVELOP CAMPUS-WIDE GENERATION STRATEGIES

For independent schools, "generation" in the context of building utilities refers to generating not only electricity but also heating and cooling to meet the needs of buildings. In establishing a heating and cooling master plan, it can often be helpful to first tackle the question of centralized versus decentralized plants.

Centralized (consolidated) plants involve larger pieces of equipment—boilers, chillers, pumps, etc.—and distribution piping to the buildings served. Decentralized (dispersed) plants put smaller heating and cooling equipment in each building and do not require a large network of plant-to-building distribution piping. Centralization offers many advantages. The first discernible benefit is the fact that consolidated plants have fewer points of failure. There are far fewer pieces of equipment to maintain, and larger equipment is typically built to a higher quality with a longer life expectancy. Secondly, large boilers and chillers cost less per unit capacity than the smaller equipment used in dispersed plants. Additionally, serving multiple building types with varied use profiles allows the centralized plant to be downsized because of load "diversity." Finally, many schools require each building to have one or more spare boilers, chillers or pumps in the event of a system failure. Centralized plants allow for the consolidation of all redundant standby equipment, rather than one of each type per building.

The central heating plant at Hotchkiss is an example. In 2005, The Stone House Group performed a Facilities Condition

Assessment (FCA) that predicted much of the campus's distributed heating equipment would need replacement within the next 10 years. Later, when the school established its goal of carbon neutrality by 2020, it revisited the FCA and called on The Stone House Group to provide a Climate Action Plan that included completion of both an Energy Capital Investment Plan and Utility Master Plan to focus on campus infrastructure and tie such improvements to energy conservation. Working with a mechanical design engineer, Hotchkiss evaluated several different solutions (consolidated and distributed), along with operational and emissions feedback. Ultimately the best solution emerged as a centralized biomass boiler plant (burns woodchips) about ⅓ mile from the campus core. Construction of the plant and distribution piping was completed in 2012. Over the first four heating seasons, Hotchkiss has averaged approximately $300,000 a year in annual savings. The boiler plant is a showcase of the school's sustainability initiatives and the site of frequent tours.

6. PLAN HEATING AND COOLING DISTRIBUTION STRATEGIES

By now a theme should be emerging: To reduce energy costs, reduce building loads and provide only what is needed to meet them. It is wasteful to use water at 180°F to heat a building to 70°F. Similarly, it is wasteful to use 42°F water to cool a building to 75°F. Boilers and chillers run much more efficiently when they do not have to produce extreme temperatures.

From a distribution standpoint, this means provide only the amount needed, only when required. More to the point, nothing reduces energy costs better than "off." More tips:

- Install variable speed drives (VSDs) on pumps and fans to slow them down when they do not need to run at full speed. While intuition says running a pump or fan at 80 percent speed uses 80 percent power, in reality there is a cubic relationship between speed and power. A pump running at 50 percent speed actually uses less than 15 percent of the full-speed power ($\frac{1}{2}^3 = \frac{1}{8}$ = 12.5 percent).
- For a healthy indoor environment, only provide as much ventilation as necessary to the spaces requiring it, and only when needed. Fully ventilating an almost-empty building does not improve anyone's well-being and can be costly over the long term.
- Ensure that new equipment is capable of modulating its output. With on/off cooling systems, a building's inhabitants are often cold when the system is dumping frigid air and comfortable only when it has stopped, at which point the cycle repeats. Modulating systems can greatly improve thermal comfort and reduce occupant complaints.

7. LIMIT ENERGY CONSUMPTION WITH END-USE CONTROLS

Only now do we begin to consider end-use equipment. The bare minimum tool at this time is a building automation system (BAS), used to control and monitor systems. (Other terms are building management system [BMS] and automated temperature control [ATC].) Minimally, a BAS should govern heating and cooling equipment; more comprehensive management of end-use systems includes lighting and ventilation as well. A BAS allows the centralized scheduling of temperature setpoints, equipment monitoring and system troubleshooting.

To fully maximize the energy- and cost-saving potential of a BAS, a school can implement technologies such as demand control ventilation (also known as carbon dioxide sensors) on appropriate air handler systems and lighting control in relevant spaces. Lighting use can also be honed with readily available technologies such as vacancy sensing and daylight harvesting.

For boarding schools in particular, it can be a challenge to provide and manage energy in student dormitories and faculty and staff housing. Because the school nearly always pays the utility bill, it seems reasonable to clarify expectations. For example, if faculty and staff go away over winter break, the school should not have to pay to heat their homes to 70°F for 10 days or more. We find being able to change temperature setpoints from a central location—that is, without needing to enter each residence—often overcomes the single biggest hurdle facing operations staff.

Keep in mind that increasing the complexity of a campus's systems can stretch the capabilities of operations staff accustomed to doing things a particular way. Periodic maintenance is most successfully achieved through a process called retro-commissioning (if the system has never before been commissioned), or re-commissioning (if has been commissioned previously). Both are abbreviated RCx, so the distinction is often blurred. Most often, this systematic process sets out to bring systems back in line with their original control methodologies. A school can save 10 to 20 percent on energy costs by engaging a commissioning agent (CxA) for a comprehensive RCx effort every three to five years, or at more frequent intervals in some cases. Ultimately, this approach leads to ongoing commissioning.

Again, we can highlight The Hotchkiss School. Over the course of several years, The Stone House Group has commissioned to some degree all but two facilities larger than 10,000 square feet.

8. INVOLVE THE COMMUNITY

While most energy-efficiency improvements are rather straightforward, changing the behaviors of students, faculty and staff to conserve energy can be much more difficult. Business officers and facilities managers should lead conservation efforts at independent schools by:

- Championing previous success
- Developing heating and cooling temperature policies
- Identifying opportunities to conserve energy (winter break, spring break, long weekends)

> "A SUCCESSFUL CAMPUS-WIDE ENERGY MANAGEMENT APPROACH REQUIRES THOROUGH PLANNING, A HIGH-LEVEL COMMITMENT AND CONSTANT VERIFICATION."

- Guiding "sustainability clubs" that elevate the importance of conserving energy
- Publishing current and historical energy data to encourage transparency

The Hotchkiss School has taken community involvement to the next level by completing each of the initiatives above, as well as by inviting the community on tours of its central biomass heating facility. These tours help ensure that the plant is not only a facilities management space, but also an extension of the classroom.

9. CAPTURE INCENTIVES AND EVALUATE FINANCING OPTIONS

At least 30 states have renewable portfolio standards (RPS) and/or energy efficiency targets that mandate both the amount of energy that must come from renewable resources and the amount of energy efficiency savings that utility companies must incentivize. To the latter point, many utility companies have either an "RPS Charge" or "Societal Benefits Charge" that funds investment in renewables and energy efficiency. Independent schools take advantage of such rebates through utility programs that provide incentives for steps ranging from replacing old equipment with more efficient models to comprehensive "whole building" energy improvements.

In addition, some energy incentive programs offer alternative financing structures that enable schools to make energy improvements without capital investments. In the past, The Hotchkiss School has borrowed funds from endowment to complete energy conservation projects and repaid the endowment fund with interest—an approach sometimes known as a "revolving loan fund" or "green energy fund." Additionally, the school has borrowed from a local bank to implement LED retrofits, based on estimated energy savings. Regardless of ability to fund energy conservation projects internally, all independent schools should evaluate the potential for incentives as well as financing options prior to upgrading facilities.

10. UNDERSTAND YOUR CAMPUS'S POTENTIAL FOR RENEWABLE ENERGY

Renewable energy projects can achieve or beat grid parity pricing through a combination of tax credits, renewable energy credits (RECs), grants and high-efficiency technology. Many schools have taken advantage of these benefits to install solar arrays, wind turbines, geothermal heating and cooling systems, and biomass heating systems on their campuses. However, recent history has proven that the market for renewable energy projects can change swiftly. In Pennsylvania, New Jersey and Connecticut, for instance, changes in legislation have produced booms as well as busts in this market. Independent schools that are not prepared to move forward with renewable energy projects may "miss out" on opportunities with short decision-making timelines.

Being prepared means that a school has:

- Evaluated its potential for renewable energy:
  - Are there locations where solar panels can be installed on roofs, on the ground or as parking canopies?
  - If natural gas is not available and the school is heated with oil, are biomass fuel deliveries practical?
  - Is it feasible to introduce a biomass heating fuel on campus: wood chips, straw pellets or corn husks?
  - Will local codes allow for wind turbine installation on campus?
  - Is there potential to dig either vertical or horizontal wells for geothermal heating and cooling?
- Identified potential for REC or grant funding
- Identified donors who may be interested in funding renewable energy projects or partnering with the school to capture tax credits
- Identified potential project partners to design, install and finance systems
- Educated the board about the potential for cost-beneficial renewable energy on campus
- Identified the right financial conditions that would allow the school to pursue a renewable energy project

A successful campus-wide energy management approach requires thorough planning, a high-level commitment and constant verification. Independent schools that do this most successfully have a deep commitment to sustainability and view their facilities as part of a living-learning laboratory.

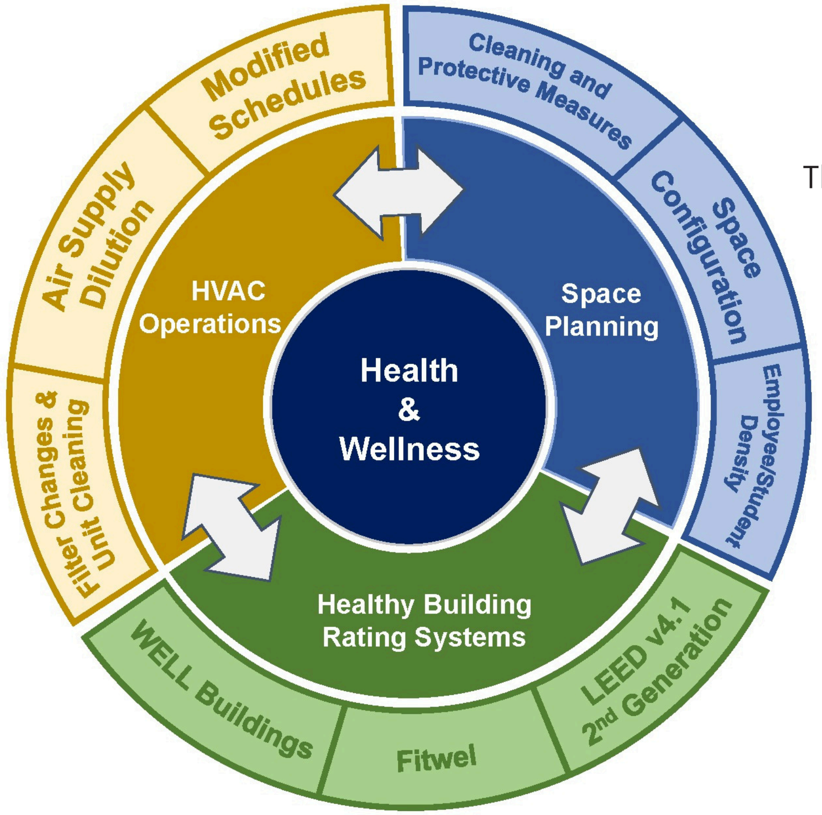
Independent schools should work with their facilities management staffs to take the first steps in collecting energy data and reviewing procurement contracts, while also developing campus-wide energy generation and distribution strategies. In the 15 years since The Hotchkiss School began work on its highly evolved energy management program, the school has reduced its energy consumption, energy costs and greenhouse gas emissions while reducing deferred maintenance and integrating best practices into the classroom. By following the steps outlined in this article, business managers will be in a strong position to develop successful energy management strategies at their schools. ■

__Lawrence Eighmy__ is a founder and managing principal of The Stone House Group, which provides energy, facilities and sustainability consulting for not-for-profit and professional clients.

THE HEALTHY BUILDING MOVEMENT

authored by Larry Eighmy and James Hayes
The Stone House Group
published in NBOA Net Assets in September, 2020

The industry of higher education has often led the sustainability movement by shaping platforms for comprehensive strategic planning and ranking institutions by the level of commitment and dedication to sustainability as seen in their programming, facilities, and overall campus culture. How will the concept of sustainability evolve as students return to the academic year in the current pandemic environment? And as we eventually move to a post-pandemic world, what long-term changes will be made? A parallel movement is dawning as these questions are asked constantly by business officers and program managers at educational institutions; a movement that recognizes a typically undervalued component of high-performance buildings, the health and wellness of building occupants.



The Stone House Group developed a comprehensive Healthy Building Service Plan that incorporates HVAC Operations, Strategic Space Planning, and Rating Systems, to deliver a complete guide.

Re-prioritizing the 3 Pillars of Sustainability

The COVID-19 pandemic has placed a new emphasis on health and wellness in our school buildings. Most immediately, healthy buildings begin with short-term HVAC Operations and space planning strategies that support their reopening plan this fall. These efforts can be extended with Healthy Building Rating Systems.

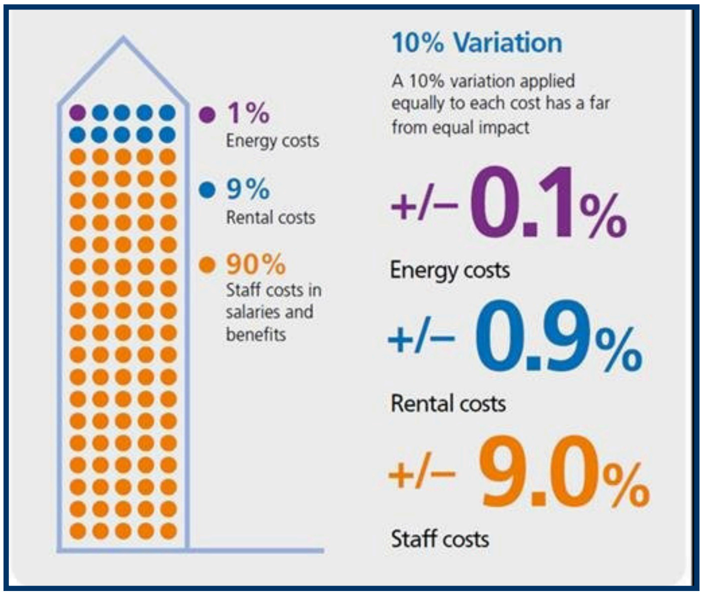
A longer-term outlook will lead us to consider what makes a building healthy beyond the pandemic. While the primary standards for ranking high performing buildings used to be energy based — for example, ENERGY STAR or LEED ratings — we may soon be evaluating buildings with a broader focus on health and wellness. Rating systems like WELL and Fitwel, which reward measures that improve health and safety, may soon be as prevalent as LEED buildings.

Financial Implications

One of The Stone House Group's foundational philosophies has been that "Energy is a barometer of facilities stewardship." We often found that educational institutions with low energy costs were also well maintained with minimal deferred maintenance. Pre-COVID-19, a key focus for building operators was to reduce energy consumption. The pandemic has resulted in a radical shift in our approach in what defines sustainable and well operated facilities; the health and wellness of building occupants. The graphic on the following page provides a financial rationale for focusing on health and wellness.

The cost of people – salaries and benefits – generally represents 90% of a facility's operating costs. Therefore, strategic investments in facilities can reduce health care costs and absenteeism, better test scores in schools, increase productivity in offices, and result in earlier discharges from hospitals. Studies such as Haverinen-Shaughmessy's "Association between substandard classroom ventilation rate and students' academic achievement" support the concept that improving indoor air quality (by increasing HVAC ventilation rates) results in improved academic achievement of students.

How much more will it cost to operate facilities focused on the health and wellness of occupants? Many facilities over the summer of 2020 were unoccupied, and astute building operators set back



*Courtesy of the World Green Building Council

HVAC systems to ensure they did not operate at full capacity while empty. This type of facility likely consumed 30% less energy compared to a pre- COVID baseline. As facilities prepare to open this fall, we recommend that operators implement higher filtration standards and increase air changes per hour to improve air quality, reducing the risk of airborne COVID-19 transmission. A facility with improved air quality will likely consume 30% more energy when compared to a pre-COVID baseline. Campus operators should be prepared for a large swing in energy costs from the summer to fall months, and year-over-year energy cost comparisons will likely show significantly higher energy costs in the Fall of 2020 as compared the Fall of 2019. This tradeoff: higher energy costs in exchange for healthier faculty, staff, and students, is one that Business Managers will gladly make in today's environment. In a post-pandemic world, we envision campus operators will have a continued focus on health and wellness while operating as energy efficiently as possible.

Health and Wellness Building Rating Systems

Throughout the U.S and abroad, green building certification programs continue to catalyze increasing sustainability and performance in building design and construction. These solutions take one of two forms: prescriptive- or performance-based certification programs. Whereas prescriptive-based programs target the materials and equipment that comprise a building design, performance- based programs specify particular performance thresholds for the building. Prescriptive paths are a rapid, definitive, but conservative means towards verification compliance, and performance-based programs typically require a year of monitoring and verification following construction completion to demonstrate compliance.

Sustainability also extends beyond high-performance buildings into the culture, policies, and programming of the institution. With the abundance of opportunities to demonstrate dedication to the sustainability movement, the industry has developed several platforms for competitively ranking these institutions by how "green" they are. The table below summarizes these key points.

Program Type	Sustainability	Health and Wellness
Perscriptive Project	LEED, Green Globes	LEED v4.1 / Fitwel
Performance Project	Passive House, Net Zero Energy	WELL
Institutional Ranking Platforms	Princeton Review, STARS, Climate Leadership Challenge	TBD, *this is the future of the Healthy Building Movement*

The outset of the Healthy Building Movement will begin similarly to the Sustainability Movement, with prescriptive programs, often project-based, such as LEEDv4.1 and Fitwel that provide a guided method to a high-performance building that emphasizes the health of its occupants. Performance-based programs such as WELL provide an opportunity to meet aggressive goals in much the same way Passive House prioritizes the contiguous building envelope and airflow of a building, and Net Zero Energy focuses on the energy consumed and produced through a performance period.

LEED v4.1 (Second Generation)

In response to COVID-19, the U.S. Green Building Council has declared a “second generation” of the organization and has announced that it will update its rating systems to prioritize health. The updated rating system is set to be released at the end of 2020. Several immediate plans include four new LEED pilot credits designed to help building teams provide healthy spaces and safe re-entry. This shift in focus from one of the most well-recognized green rating systems in the world encapsulates the essence of this movement, and will undoubtedly signal other organizations to follow a similar path, thus paving the way forward for a broader shift in high-performance buildings overall.

Fitwel

The Fitwel rating system, developed by the Center for Disease Control (CDC) and the General Services Administration (GSA), aims to help employers evaluate all design factors to create a healthy space for building occupants and visitors. Fitwel incentivizes certification with low registration and certification fees, and a lack of prerequisites. Common categories of project evaluation include proximity to public transit, outdoor spaces, indoor air quality, access to healthy foods, and workspace design. Fitwel is well- positioned, having launched in 2016. Fitwell recently introduced their Viral Response Module, which provides annual, third-party certification of policies and practices informed by the latest public health research on mitigating the spread of contagious diseases. Academic facilities can be Viral Response Certified or Certified with Distinction.

WELL

WELL is a rating system for measuring, certifying and monitoring features of the built environment that impact human health and wellbeing, through air, water nourishment, light, fitness, comfort, and mind. Unlike Fitwel, the WELL rating system takes a performance-based approach to certification, which moves the Healthy Building Movement forward one step on our table. Projects pursuing WELL certification are required to be evaluated and inspected by a WELL Assessor. WELL was developed by Delos, a wellness real estate and technology firm, and launched in October 2014. It is managed by the International WELL Building Institute, a public benefit corporation. Similar to LEED, WELL is third- party certified by the Green Business Certification Incorporation. WELL just recently began offering their WELL Health-Safety Rating for Facility Operations and Management, which is an evidence- based, third-party verified rating for all new and existing buildings focusing on operational policies, maintenance protocols, stakeholder engagement and emergency plans.

The arrival of this movement is further evidenced by the creation of subsidiary certifications within Fitwel and WELL focused entirely on the mitigation of infectious diseases.

Fitwel’s Viral Response Module provides annual, third-party certification of policies and practices to mitigate the spread of infectious diseases within facilities. In two months, buildings can be certified by the Center for Disease Control to effectively combat the spread of disease, and safeguard building occupant’s health. The introduction of the WELL Health-Safety Rating again provides evidence-based, third-party verified certifications that demonstrate the building owner’s commitment to the health of building occupants. Moreover, the description of the certification on WELL’s website reads “[the certification] was informed by the COVID-19 pandemic, but has broader applicability for supporting the long-term health and safety needs of people in a given space." Both certification programs discuss the importance of cleaning and sanitization strategies, air and water quality management, and communication of building changes to occupants. Furthermore, both certifications introduce measures that impact tenants long-term, including emergency preparedness plans, mental health training, and sick leave policies. Anthropogenic policies and standards such as the ones identified in these certification programs will likely be as prevalent as energy consumption reduction measures.

Institutional Ranking Platforms

As more institutions pursue certifications signifying their commitment and dedication to their occupant's well-being, a need will arise among consumers to identify and rank these institutions by the number of certified facilities, or policies for new construction, or the culture promoted within the facilities. For example, SecondNature has led this need for higher education institutions, by creating the Climate Leadership Challenges and pushing a higher standard for carbon emissions reductions. The Sustainability Tracking and Rating System (STARS), used by Climate Commitment institutions, ranks institutions on a five-tiered scale to identify the sustainability performance of participating institutions. Notably, STARS requires institutions to provide feedback on the following question: Are school buildings that were constructed or underwent major renovations in the past three years LEED certified? Industry growth suggests that this question will be broadened to include healthy building rating systems such as WELL and Fitwel. Reopening facilities with a healthy building certification assures building users that measures have been taken to prioritize human health and wellness during these uncertain times.

Join the Movement

The pandemic has presented us all with a unique opportunity to prioritize the health and wellness of occupants and promote a somewhat undervalued component of sustainability – people – and building owners are encouraged to modify their operations and spaces to demonstrate this commitment. Just as the sustainability movement launched from within college campuses, the health and wellness movement will similarly grow within educational institutions. This movement begins with immediate modifications to HVAC systems and space reconfiguration, culminates in healthy building certifications such as WELL, Fitwel, or LEED v4.1, and will be followed with a platform to measure performance and rate peer institutions. How will your facilities compare?

The Stone House Group is a facilities and environmental consulting firm dedicated to strengthening the mission of institutions. Since our foundation in 1999, we have served over 150 educational clients across the United States through Facilities Audits, Space Planning, Commissioning, LEED Administration, and others.

Inflation Reduction Act | Investment Tax Credit Recovery

CLIENTS SERVED

Higher Education

- Bucknell University
- Dickinson College
- St. John's University
- Juniata College
- Manor College
- Ursinus College

Independent Schools

- The Pingry School
- St. Andrew's School

DICKINSON COLLEGE
Solar Array Project
CALISLE, PA

The Inflation Reduction Act (IRA) is a landmark piece of legislation in U.S., providing substantial funding and incentives to drive the shift toward a clean energy economy. A key feature of the IRA is the Investment Tax Credit (ITC), which reduces the cost of installing renewable energy systems by offering a tax credit of 30-50% of the project's installation expenses.

Direct Pay Option

The Inflation Reduction Act offers a direct pay option for not-for-profit organizations, allowing them to receive incentive payments directly from the Department of the Treasury. This applies to Investment Tax Credits available for clean energy systems. Eligible organizations can treat these tax credits as refundable, meaning they can receive a direct payment from the IRS for any amount of credits that exceeds their tax liability.

Eligible Technologies

- Solar Technologies
- Small Wind
- Ground Source Heat Pump
- Microturbine
- CHP
- Microgrid Controller
- Standalone Energy Storage Systems
- Thermal Energy Storage Systems
- Fuel Cell
- Geothermal
- Biogas
- Waste Energy Recovery
- Interconnection Property
- Electrochromic Glass

SHG CONTACTS

Larry Eighmy
Managing Principal
eighmy@theshg.com

Darren Cassel
Principal
cassel@theshg.com

Robert Butch
Principal
butch@theshg.com

James Hayes
Associate Principal
hayes@theshg.com

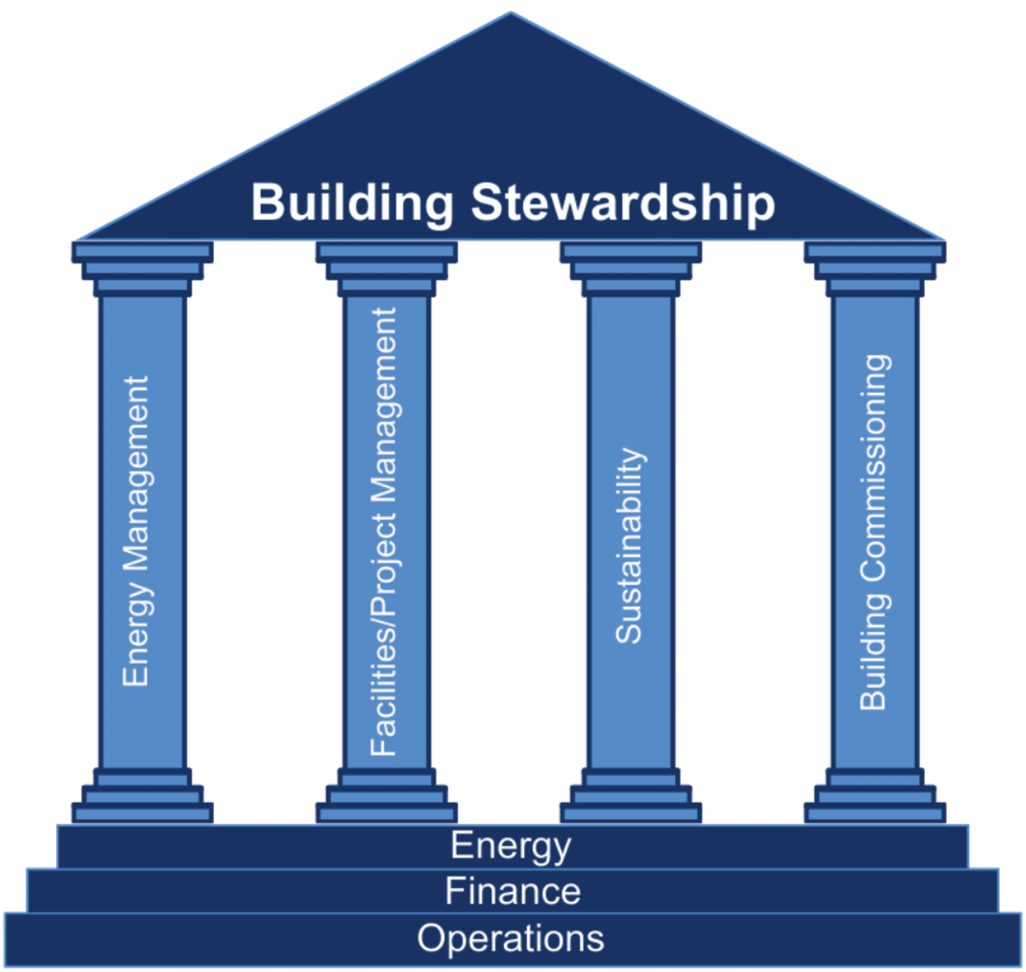
The Stone House Group | Firm Profile

The Stone House Group is a facility-consulting group dedicated to strengthening the mission of institutions. We believe your institution's mission should be supported, not undermined, by your facilities. To this end, the buildings and grounds must be safe, well-maintained, and function dependably and efficiently, using minimal yet appropriate resources.

COMPANY MISSION STATEMENT

The Stone House Group can make your facilities effectively support your mission. We offer comprehensive, yet individualized facilities planning, management, and operation consulting. The Stone House Group is named after the simple, sturdy structure in which we held our first company meeting; it represents the quality and integrity of the services we provide.

The Stone House Group offers a unique array of expertise and experience that provides clients with a variety of interrelated services that focus on the distinctive needs of not-for-profit organizations. The Company has over 20 associates and is based in Bethlehem, Pennsylvania with an additional office in Washington, DC. Since our founding in 1999, The Stone House Group has served more than 500 clients. Our primary service areas include the following:



CERTIFIED B CORPORATION

CERTIFICATION ACHIEVED	2022

B CORPORATION certification is to sustainable business what LEED certification is to green building, or Fair Trade certification is to coffee. B Corporations are certified by the nonprofit B Lab to meet the highest standards of social and environmental performance, legal accountability, and public transparency. They aspire not just to be the best companies in the world, but the best for the world. Our aspiration is to move past twentieth-century capitalism and into the twenty-first century, serving both stakeholders, and society. There are over 4000 companies certified in more than 70 countries, and over 150 industries. THE STONE HOUSE GROUP is one of the first 40 consulting firms in the United States with less than 50 employees to achieve B-Corp Certification.

We spent over 5 years working towards achieving our B-Corp Certification. This process required transforming our internal and external processes and demonstrating our commitments. To achieve certification, organizations must score at least 80 points. Over 66% of THE STONE HOUSE GROUP's points come from two Impact Areas: Workers and the Environment. This demonstrates that THE STONE HOUSE GROUP contributes to our employees financial, physical, professional, and social well being, and that our services have a positive impact on environmental sustainability.

We are not stopping here; our next B-Impact Assessment will occur in 2025, and our goal is to increase the Company's score by 10 points.

Certified B Corporation™

For THE STONE HOUSE GROUP, B Corporation will help us track the environmental impact we have as a result of our work, and we have already taken several steps to achieve this goal. A number of new policies have been drafted that embed sustainability into our company's DNA. Additionally, we will continue to manage an energy, water, and GHG emissions database, and track our environmental influence on our clients through measuring Greenhouse Gas emissions reductions as a result of our services.

Services

Total Clients Served:

500+

The Stone House Group is a facilities consulting firm dedicated to stengthening the mission and distinctive needs of academic, private, and not-for-profit institutions. We offer comprehensive, yet individualized energy management, facilities management, commissioning and sustainable design services. We conduct our business with respect for our community and the environment, building relationships by championing and challenging our clients' facilities to effectively support their mission. Since our founding in 1999, our team has grown to over 20 professionals that hold a range of certifications including PE, CEM, CCP, LEED AP, REP, and BECxP.

Energy Management

Climate Action Planning
Energy Audits
Energy Capital Investment Plan (ECIP)
Energy Modeling
Energy Procurement
Greenhouse Gas Inventory
Master Planning Support
Renewable Energy Consulting
Utility Master Planning

Facilities Management

Facilities Benchmarking
Facilities Condition Assessment
Facilities Management
Facilities Operations Assessment
Master Planning Support
Owner's Representation
Project Management
Space Planning
Recruitment

Flat Iron Building
Home to The Stone House Group

Sustainability

Building Envelope Consulting
Education for Sustainability
LEED Consulting
Sustainable Design Consulting

Building Commissioning

Building Envelope Commissioning
Commissioning (LEED & non-LEED)
Retro-Commissioning
Thermal Imaging

Client Sectors

INDEPENDENT SCHOOLS: **110+**

PUBLIC SCHOOLS & DISTRICTS: **15+**

CHARTER SCHOOLS: **5**

COLLEGES & UNIVERSITIES: **35+**

CORPORATE CLIENTS: **60+**

HEALTHCARE & MEDICAL CLIENTS: **15+**

COMMUNITY & RECREATION CLIENTS: **50+**

PENNSYLVANIA

Total Clients Served	111
Education	62
Corporate	16
Community, Recreation & Government	23
Medical & Healthcare	10

CLIENTS

Education

Higher Education
ALBRIGHT COLLEGE
BUCKNELL UNIVERSITY
BRYN ATHYN COLLEGE
DICKINSON COLLEGE
EAST STROUDSBURG UNIVERSITY
GETTYSBURG COLLEGE
HAVERFORD COLLEGE
JUNIATA COLLEGE
LEHIGH UNIVERSITY
MESSIAH COLLEGE
PA STATE COLLEGE OF MEDICINE
PENN STATE UNIVERSITY
SWARTHMORE COLLEGE
URSINUS COLLEGE
VILLANOVA UNIVERSITY
WILSON COLLEGE

Independent Schools
ABINGTON FRIENDS SCHOOL
ACADEMY OF NOTRE DAME DE NAMUR
CITY SCHOOL AT SPRUCE HILL
CHESTNUT HILL ACADEMY
DARCY SCHOOL
DELBARTON SCHOOL
DELAWARE VALLEY FRIENDS SCHOOL
EPISCOPAL ACADEMY
FRANKFORT FRIENDS
GEORGE SCHOOL
LASALLE COLLEGE HIGH SCHOOL
MALVERN PREPARATORY SCHOOL
PERKIOMEN SCHOOL
PHILADELPHIA SCHOOL
SPRINGSIDE SCHOOL

Public School Districts
BETHLEHEM AREA SCHOOL DISTRICT
DOWNINGTOWN AREA SCHOOL DISTRICT
WISSAHICKON SCHOOL DISTRICT

Corporate

ALLENTOWN WATERFRONT
ALVIN H. BUTZ CENTER
ARTSQUEST
AMAZON
BEN FRANKLIN TECHNOLOGIES TECH VENTURES
GUARDIAN LIFE INSURANCE
HILTON GARDEN INN, EXTON
KIMBERLY CLARK
LIBERTY PROPERTY TRUST
MARTIN GUITAR
MARRIOTT RESIDENCE INN, EXTON
NATIONAL MAGNETICS COMPANY
PAISBOA
SYCAMORE HILL FARM DEVELOPMENT
TRUMBAUERSVILLE FIRE COMPANY
TWO CITY CENTER AND THREE CITY CENTER, ALLENTOWN

Community, Recreation & Government

ALLENTOWN ART MUSEUM
CENTRAL MORAVIAN CHURCH
CHURCHVILLE NATURE CENTER
CUMBERLAND VALLEY ANIMAL SHELTER
EASTON CITY HALL
FRIENDS OF THE NATIONAL PARKS AT GETTYSBURG
GETTYSBURG HERITAGE
HARRISBURG COMMUNITY ACTION COMMISSION
HOOVER MASON TRESTLE
LANCASTER COUNTY
NEWTOWN TOWNSHIP
NORTHAMPTON COUNTY
PHILADELPHIA ZOO
SOCIETY HILL AT SAUCON VALLEY
ST. ANDREW'S EPISCOPAL CHURCH
ST. DAVID'S EPISCOPAL CHURCH
SUSTAINABLE ENERGY FUND
UPPER MAIN LINE YMCA
VIGILANT FIRE COMPANY
TEMPLE BATH EI
WILLISTOWN FRIENDS MEETING
WOMEN IN NEED
YSC SOCCER

Medical and Healthcare

BENCO DENTAL CENTER POINT OFFICE
EASTON CENTER FOR SPECIALIZED SURGERY
GEISINGER HEALTH SYSTEM
HOLY REDEEMER
LEHIGH VALLEY EYE CARE CENTER
NEW BRITAIN SURGICAL CENTER
PENN STATE HERSHEY MEDICAL CENTER
POTTSVILLE AMBULATORY SURGICAL CENTER
ST. LUKE'S UNIVERSITY HEALTH NETWORK
VIROPHARMA INC.

For a full list of Pennsylvania clients, please visit our website.

Energy Procurement Services

Total Clients Served 82

The Stone House Group will work with your organization to develop an energy purchasing strategy that best meets your business objectives and coordinate an online reverse auction with multiple suppliers to achieve the best price and terms for your purchase.

Four Methods to Manage Energy Procurement Risk

Indexed

Customers have the choice to pay the market Day-Ahead or Real-Time price for all energy consumed, effectively following the movement of the wholesale energy markets.

Hybrid / Block & index

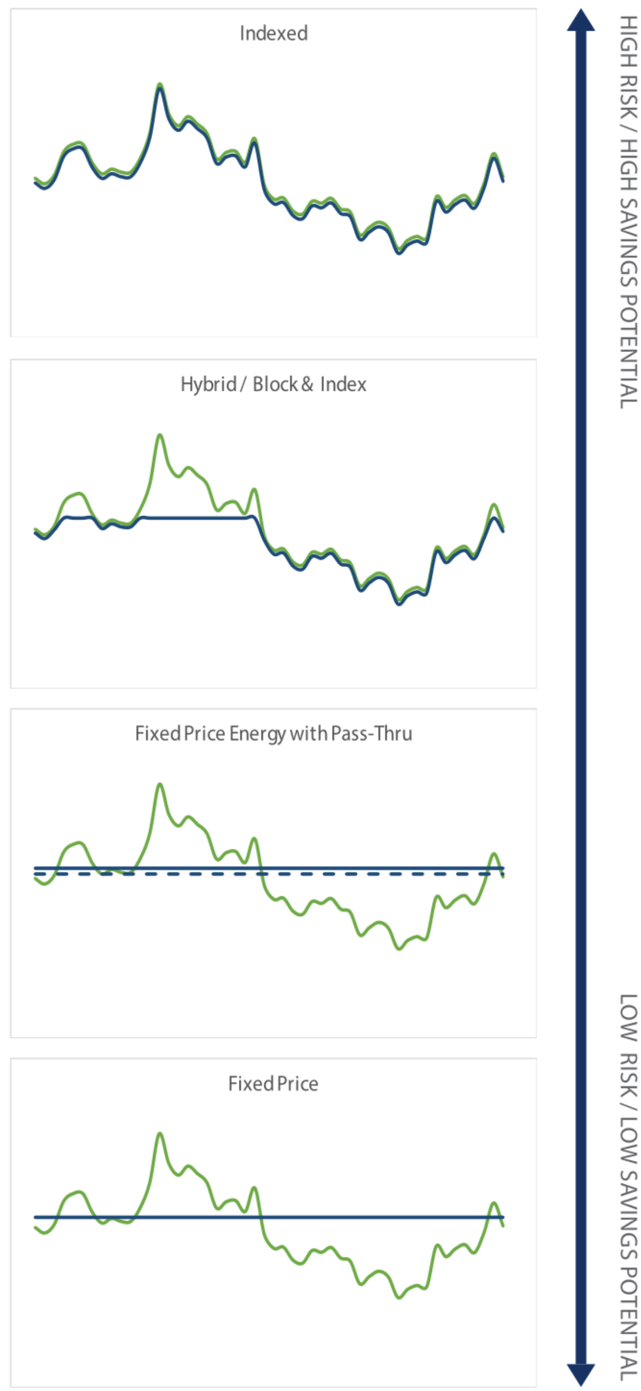
Various options exist to combine a fixed product with an indexed product. A hedging strategy tailored to your needs allows for a certain degree of budget certainty, while retaining the ability to take advantage of favorable market swings.

Fixed Price Energy with Pass-Thru

Energy supply contracts consist of various wholesale components bundled together. By unbundling - or "passing through" - some of these components, the overall price is slightly lowered and opportunities are created for further price reduction through peak demand management (e.g. PLC reduction with Capacity Pass-Thru).

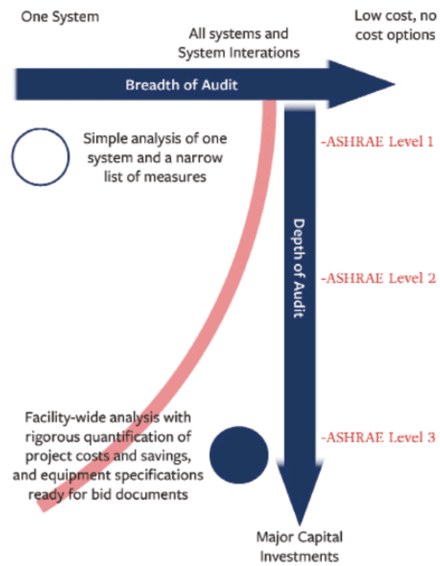
Fixed Price

A fully fixed energy supply contract with all price components bundled together creates budget certainty and limits your exposure to the volatility of energy markets.



Energy Audit Services

TOTAL CLIENTS SERVED	30+
EDUCATION	25
CORPORATE	4
COMMUNITY, RECREATION, AND GOVERNMENT	4



Description of depth and breadth of the three levels of ASHRAE energy audits.

ASHRAE ENERGY AUDITS

The various levels of energy audits vary in depth and complexity. Level 1 uncovers major problems with with a survey of the building, and identifies capital improvements that merit further consideration. Level 2 includes a detailed building survey that identifies energy conservation measures (ECMs) specific for each building. The most in-depth audit is a Level 3, which involves reviewing the ECMs and data gathered from previous audits and estimate the cost and savings of each ECM, as well as determine and quantify all applicable rebates and incentives.

Most of our clients choose an assessment level somewhere on the red trend line in the graphic to the right, and we have created a hybrid of ASHRAE Level 1 and 2 audits to satisfy clients that seek to find something in between: Level "1.8". The primary deliverable in completing the audit is an Energy Capital Investment Plan (ECIP), which identifies each project and associated capital cost, savings, ROI, maintenance practices, and operating methods. We review the list of projects with the owner or operator to identify the most favorable projects, and then estimate the effect of each project on maintenance costs, building operations, and non-energy operating costs.

Dickinson College in Carlisle, Pennsylvania. THE STONE HOUSE GROUP completed Level 1, 2, and 3 energy audits, including a campus-wide (1.6 million gross square feet) Level 1 audit.

CLIENTS

HIGHER EDUCATION
Connecticut College
Dickinson College
Haverford College
Juniata College
Lafayette College
Princeton University
Swarthmore College
Ursinus College
Villanova University

INDEPENDENT SCHOOLS
Abington Friends School
Chapin School
Elisabeth Morrow School
Episcopal Academy
Fessenden School
Garrison Forest School
Hotchkiss School
Notre Dame High School
Perkiomen School
Princeton Day School
Riverdale Country School
Stuart Country Day School
St. Joseph's High School
Wardlaw-Hartridge School
Upper Moreland School District

CORPORATE
Becker Ear, Nose, & Throat, LLC
Hilton Fukuoka Sea Hawk Hotel
Hilton Millennium, NYC
Related Management

COMMUNITY, RECREATION, AND GOVERNMENT
Central Moravian Church
Massonic Village Retirement Community
Metro-North Railroad NYC
Philadelphia Zoo

WORKSHOP RESOURCES

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Contact

Email: **greencolleges@gmail.com**

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