Decarbonizing Manufacturing Plants with a Trained Workforce

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ABSTRACT

While advancements in new technology continue, the aging building stock in New England has not kept pace and much of the technology in the manufacturing plants across Connecticut is considered out-of-date. Leveraging energy efficiency as a strategy for decarbonization and working against climate goals is critical in plants such as these. To support these facilities however, the next generation of energy and facilities professionals needs to be trained to recognize older process, mechanical and lighting equipment, in addition to emerging technology solutions, because they will often face this older equipment when designing optimization strategies. While many curriculums focus on advancements in technology, like heat pumps, incorporating older technology into trainings will better prepare newer energy professionals to identify older systems, understand why certain equipment was chosen, and effectively propose customized energy reduction strategies.

This paper will outline a timeline of manufacturing and energy efficiency in Connecticut and demonstrate how understanding the past can help us devise our way forward to achieve deep greenhouse gas savings in manufacturing plants. Understanding the past can help energy professionals better design programs and projects to achieve climate goals for their organizations.

Introduction

Earth's civilization is currently at a turning point in our relationship with the planet. There are countless scientific studies noting that Earth's climate has been warming and most academics would agree that human beings have had a very negative effect on the health of our environment. Regardless of one's standpoint, being responsible stewards of the environment should be everyone's concern for the future of our planet. The idea of energy conservation is nothing new, but the concepts of how energy is being generated and used are being seen from a new prospective. The idea of responsible energy use and the reduction of greenhouse gases (GHG) as well as our carbon footprint has been brought to the frontline.

Energy conservation practices of ten, twenty, or thirty years ago are valid, but improvements above financial savings and payback are now at stake. Many companies now look to have carbon neutrality goals and even include them in their mission statements. Many industries will be challenged to be 100% carbon neutral; however, it is the task of the energy efficiency professionals to push manufacturers and industrials to dig deeper in all practices to find efficiencies. Technologies that once would have been incomprehensible from a financial perspective are being considered because of their positive effects on a GHG goal. This realization has created a sea change in perspective and according to the 2020 US Energy and Employment report, there were an additional 54,000 jobs created in 2019 around energy efficiency. As the demand for efficiency continues to rise so too should the demand for energy efficiency professionals.

Globally, buildings account for approximately 37% of all CO2-based emissions (UNEP, 2021), so making them as efficient as possible should be a major goal for all parties. The challenge of understanding buildings based on age and design as well as their mechanical systems can be a difficult task and perhaps even more daunting to a young professional entering the energy efficiency field. As technology continues to develop, the world of energy efficiency continues to evolve, and it becomes imperative that the more experienced energy pros hand off their years of historical knowledge to the incoming masses of young professionals. Understanding the equipment that is being proposed is very important, as is the ability to know about the systems that are being replaced. Even systems from generations past allow the new crop of experts to have a firm grasp on not only why a building was built a certain way, but also why it had been operated as it had. Understanding the history of manufacturing facilities, their occupants, and their operators becomes critical in understanding how they can be operated more efficiently

"A generation which ignores history has no past – and no future." -Robert A. Heinlein

A Brief History of Manufacturing in the Northeastern United States

The history of manufacturing in the Northeastern United States begins early in the settling of the colonies and ultimately the foundation of the country. One of the many reasons for European interest in colonizing the new territory was the wealth of natural resources, including everything from timber to precious metals. Early colonists were heavily reliant on finished goods from Europe and the transfer of raw materials from the Americas to Europe and the return of finished products was a slow and arduous endeavor.

As the colonies broke away from British rule in the late 18th century, there was a level of uncertainty as to the path that this new country was to take; however, anyone who has read Ron Chernow's biography of Alexander Hamilton can tell you that the new country was under the guidance of some of the greatest political minds in history. Not only was this group of Founding Fathers able to navigate the uncharted waters of a new nation, but they were also able to partner with other countries and stabilize their financial future. While the system that was developed was by no means perfect, it allowed for record-setting growth in the 19th and 20th centuries in ways that few could have anticipated.

The life of a family during this time was not easy and consisted mostly of heavy manual labor with very little mechanical advantage to ease the burden of most tasks. Cutting timber for a home was still done with an axe and bucksaw; the process of cutting timbers to dimension was completed via a pitsaw and a hewing technique, called juggling or joggling, with two workers simultaneously removing material from a log. These timbers were hauled by horse and wagon to a building site and were assembled with hand wrought nails made by a blacksmith. A community revolved around a craft economy of specialists; each manufacturing one-off pieces to serve their purpose. At this point in time, the reality of mass production was still a distant concept.

England in the late 18th Century began to see a technological boom in manufacturing processes. The tensions between the newly founded United States and England continued to grow more hostile to a point where emigration of mechanics and workers was banned. Given that, still a handful of mechanically-gifted men made their way to the new country with plans for water-powered mills. These mills took many of the repetitive tasks of manufacturing and streamlined them, allowing the workforce to focus on greater production. The first textile mills were constructed in Pawtucket, Massachusetts and future mills followed suit throughout New England, lining the many rivers churning out products that used to take exponentially more time to fabricate. (Corbett et al. 2014).

After the War of 1812, the expanse of this industrial revolution continued with no end in sight. While steam had been used in the past, it had been more effectively harnessed through several inventors including Thomas Savery, Thomas Newcomen, and James Watt. This technology was first used for pumping, but quickly led to transportation and manufacturing (Britannica, 2022). While the United States offered vast resources, the challenge of transporting raw materials led to the construction of the 363-mile-long Erie Canal, providing a path from Lake Erie to the Hudson River and ultimately out to the Atlantic. The canal opened westward expansion and helped advance the availability of resources for manufacturing. The canal's life was abbreviated by the progression of the transcontinental railroad, removing the reliance on waterways for transportation. These developments allowed for the continued evolution of manufacturing throughout New England, including everything from hats and textiles to brass, springs, and screws.

New England experienced significant manufacturing growth throughout the 20th century, but even more extensive growth was seen in the aerospace and firearms manufacturing segments due to the advent of World Wars I and II. Connecticut's own Pratt & Whitney Machine Tool Company was one of the first engine builders able to build an aircraft engine that produced 425 horsepower weighing only 650 pounds. This success drove the company to improve their technology and by 1940, when President Roosevelt tasked the US with gearing up for war, the company's engines were producing up to 2,000 horsepower just in time for the request for 50,000 military aircraft per year. By 1943, Pratt & Whitney had expanded its workforce from 3,000 to 50,000 workers (Deluca, 2021). This story was repeated throughout New England with firearm manufacturers Colt, Winchester, Remington, Smith & Wesson, Springfield and Savage to name a few.

Innovation in manufacturing and advancement in technology led to improvement in the construction and operation of factories. As electricity began to be more commonplace, it allowed for facilities to move away from steam, hydro, or other sources to rely on electric motors for manufacturing power and, of course, lighting.

Energy Efficiency Practices Through the 20th and 21st Centuries

Efficient production was the primary focus of manufacturers for this time with little concern over the safety of the workers or the environment being seen until midway through the 20th century. At this point, regulations began to be put policies in place for safer work environments and to take more responsibility for cleaner and more sustainable manufacturing of goods. The advent of automated machinery was key to the advancement of manufacturing. These technologies not only allowed for longer hours of operation, but also more comfortable working conditions and greater throughput.

Prior to electricity being available, production was limited to daylight hours and therefore factories were built with large open areas with walls of single pane windows. While electric power was slower to be rolled out to more rural areas, industrialized cities and towns took full advantage of this technology in a number of ways. Understanding the myriad ways that it was implemented as well as the advancement of the technology allows us to improve facilities more effectively.

Lighting

Early lighting consisted of traditional carbon filament lamps with very high wattage and little concern for power consumption. The lumen levels provided by this early lighting were minimal, but it was a step in the right direction. Technology continued to advance, and the concept of high intensity discharge (HID) was put into play. HID is lighting utilizing mercury or sodium-based gases in a vessel with high voltage transformers and this technology offered greater lumen output with similar wattage levels. HID lighting was often the rule for most high and low bay applications as well as many exterior fixtures.

Fluorescent technology has also played an integral part in many of the industrial and commercial spaces throughout the world. For many decades, the T12 lamp in a number of variations with magnetic ballasts was used and worked well. However, evolution in fluorescent technology, including electronic ballasts, improved electrodes and lamp coatings – allowing these luminaires to have extended life into the 21st century. Any individual who has lived through more than a decade of energy efficiency can recall when T12 lamps were converted over to T8 lamps. These lamps used electronic ballasts and systems with reduced lamp “kits” which provided relocated sockets (reducing the count of lamps being used in a luminaire) and special reflectors to extend fixture life. The final stages of the fluorescent story involve reducing wattage lamps down to 25W or 28W from the original 32W. Low power ballasts were also implemented to try to build a “recipe” for acceptable lighting levels using the lowest amount of power possible. The adoption of T5 fluorescent systems, which had been in use in Europe for some time, also saw a huge push as a replacement for the aforementioned HID fixtures. This technology allowed higher lumen levels from a luminaire using approximately half that of its metal halide counterpart.

There was also a short period where induction lighting was implemented in some areas for exterior and limited interior with the hopes of huge lumen output which touted 100,000 hour lifetimes. A few companies also attempted to extend the life of the HID fixture by offering pulse start and more efficient capacitive discharge metal halide fixtures, but these technologies would soon be overshadowed by the light emitting diode (LED).

If one was just entering the world of energy efficiency, it would be hard to know of a time before LED lighting. LED technology was discovered in the early 20th century and has been the staple for most lighting applications. The early days saw amazing lumen per watt levels and there were often discussions about how far the LED could be pushed. As of the writing of this paper, industry professionals still argue about theoretical limits, but levels have been comfortably smoothing off around the 150 lumen per watt mark. Furthermore, the ways that LEDs have been integrated into nearly every type of legacy luminaires has been astounding. The use of extruded plastics and additive manufacturing has created a canvas for LED fixture designers with few limitations.

The use of controls in lighting is nothing new. The use of photocell sensors for exterior lighting to allow for lighting to adjust with daylight hours have been in use for decades. The common rheostat dimmer that most of us grew up with in the dining room has also been in use for generations. With that, lighting controls have steadily improved over time and the way that we are implementing these controls into projects continues to evolve.

The integration of controls into each fixture has yielded not only the ability to have motion controls and individual programmability, but also allows fixtures to be grouped together into areas and zones. Furthermore, if this type of system is networked it can also yield data such as asset tracking, space utilization, HVAC integration, and geofencing. The ability to set high- and low-end dimming, motion sensing, and lighting preferences is just the beginning.

Traveling throughout the United States, it is astounding to see how many areas of the country are still utilizing the early HID and fluorescent technologies. These areas may have been slower to adopt the new technologies due to the higher price of power in the Northeast compared to the rest of the country, but we should be embracing these solutions for modern lighting regardless of price per kWh.

Compressed Air

Compressed air is often referred to as the "forgotten utility". It is one of the most-used technologies, but its efficiency ranges from 10-19%. The unit producing compressed air uses the majority of the energy producing heat while the byproduct of compressed air is made. This equipment is considered one of the first things that an energy professional will often discuss as its use is necessary, but there are many ways to be more efficient with its application.

While most manufacturers cannot conceive of functioning without their compressors, it is still a relatively young technology given the way that most manufacturers use it. The concept of using air to improve a process goes back to early civilizations, blowing on hot embers and eventually fanning them and building devices to stoke a fire. This fire was generally used in the processing of melting early precious metals and eventually in the forging of harder metals in the manufacture of tools. Later innovative uses included designs by Englishman George Medhurst who developed compressed air systems for mining and a compressed air rail system (The Evolution of Compressed Air-An Essential Element to Industry).

Compressed air became commonplace with the integration of electricity into manufacturing facilities. It can be developed via a reciprocal compressor, using a traditional piston/cylinder/valve configuration, a rotary/screw-style unit utilizing tightly tolerance impellers which compress the air or a less common jet compressors. While reciprocal compressors ruled early production facilities of the 20th century, they have been surpassed by their more efficient screw/rotary cousins for most higher horsepower applications. If reciprocal compressors are still present, they are often seen in the dusty corner of compressor rooms and only run during mechanical servicing or catastrophic failure.

Over the past two decades, Variable Frequency Drives (VFD) or Variable Speed Drives (VSD), often used interchangeably in common parlance, have lent a new level of efficiency to the compressor. This technology has allowed the compressor to be slowed down or sped up depending on the needs of the facility and can be often integrated into more complex operational strategies. Compressed air loads can be shared between two or more compressors in a lead/lag variation to extend equipment life and can provide feedback to the facilities personnel in the event that something is operating outside of its optimal parameters.

Heating Ventilation and Air Conditioning

Heating, ventilation, and air conditioning (HVAC), up until the past century, has been a relatively straightforward concept, but innovations in HVAC technology would warrant volumes of information to explain the specificities. There are many ways to currently heat, ventilate, and cool a facility, but the saving grace of anyone working in the energy efficiency world is that once one grasps the general concepts of moving heat into or out of a space, a few well-placed questions can determine how the facility is managing its interior climate.

- What type of manufacturing is taking place at this site?
- What type of fuels does the building use?
- Does the facility utilize steam?
- Does the facility have a hydronic loop?
- Is the space air conditioned?
- Does the space have a chiller or chillers?
- Does the facility use packaged roof top units (RTUs)?

At the start of industry, a manufacturing facility would have been heated by a furnace or boiler that was run for the purpose of manufacturing a product. This may have been accomplished through the burning of wood or coal and later, oil. Early comfort heating for specific areas may have had radiators or unit heaters tapped off an existing steam loop. If there were office areas, they may have had ductwork vented throughout the space so that warm air could have circulated through convective flow. Many later designs for heat, again, relied on the boiler with heat exchangers located in specific areas to keep task workers warm enough to produce. Later innovations in natural gas heating with unit heaters or infrared fin heaters allowed a more directed source of heating to the space without the long distribution losses of piping steam or water throughout an often-uninsulated space. Climate control for these later heater units was the traditional mercury thermostat that was commonly turned to its maximum output and left to sit there until the heating season was over.

Ventilation in factories was often part of the lighting system, large windows that were capable of opening and outside doors along the perimeter of the building or in the loading dock areas. These were kept open to maintain a breeze moving throughout the space. Some facilities utilized large make-up-air units with a blower to bring in outside air; these units would sometimes have a burner to add heat to the space as necessary. It is still very common in New England to find facilities that utilize all these methods as a means of keeping employees as comfortable as possible during the summer months. As has been discussed, the advancement of employee health and safety has driven improvements in ventilation as well as the capture of harmful dust, fumes, oil, and particulates. It is critical to ensure that no efficiency measure supersede these critical systems.

Air conditioning in manufacturing is not seen as common in the Northeast unless the finished product requires it. Finding a general manufacturing facility of any size that is air conditioned for the comfort of the employees is rarely seen. The finished product or materials in use generally dictate whether specific humidity must be kept, as is often seen in fine machining, pharmaceutical, or food production where sterility is a priority.

Building Management Systems

Having control over the operation of buildings in this way is a relatively young technology. The concept of controlled temperature is owed to Dutch inventor Cornelis Drebbel, born in 1572, who built the first recorded feedback device, a self-regulating chicken incubator (Callahan, 2014). This level of thermostatic control paired with pneumatic actuators were all that was used to manage building comfort up until the third industrial revolution in 1969. That is when we saw the development of the programmable logic controller (PLC). The PLC and the invention of direct digital control (DDC) in 1979-1980 revolutionized the way that buildings are monitored and controlled (Bosch, 2023).

As one can imagine, replacing equipment to control HVAC and building functionality is neither quick nor inexpensive. Some early adopters of this technology proactively replaced aged controls and modernized their equipment to have better control of their buildings. However, many would often opt to only replace aged equipment as needed. If a facility had made such upgrades in the 1980s or 90s that would mean that they would most likely be in their 2nd or 3rd generation of building control. As we have seen in the past two decades, the cost of these technologies continues to drop while power and performance has increased. Not only are there networked controls which may be proprietary or open-sourced, but the breadth of data that they can collect and interact with is staggering. For the most part, buildings are now able to monitor and regulate themselves while sounding alarms to their facilitators should something be amiss. While one would expect that the majority of buildings would have this level of control, it is still eye-opening to see how many are still controlled with static mercury thermostats, hand-controlled dampers and aged, leaking pneumatic controls. We have a long way to go until our building operation has been completely automated and optimized.

Motors and Drives

The electric motor was the vision of many throughout the 18th and 19th centuries. But the electric motor truly found its place in the late 1880s with the three-phase induction motor. This technology, paired with the expansion of electrical distribution networks throughout industrialized areas, no longer meant that motion needed to be generated by steam, hydro, or petroleum-based engines. It revolutionized the way that work could be completed by functioning wherever there was electricity. Electric motors continued to be more refined into the 20th century in both efficiency and size. It has been noted that a 100HP motor today would be the size of a 7.5HP motor in 1897 (Alger, 1976). It is still commonplace to see motors throughout the northeastern United States dating back to the 1940s in many of the smaller factories- most in which they are stamping and punching metal or making springs. However, motor efficiency has increased significantly over the past couple decades.

The added efficiency of motors, paired with different technologies including soft start devices have been integral to long motor life and efficiency. However, the VFD, once suitable for only the largest of motors, has been made scalable due to lower cost of equipment. A VFD tied into a PLC with the proper feedback can provide significant savings for motors being used in pumps and fans, blowers, and HVAC systems. They can also be used for other applications such as mixing and compressors, provided they have logic to define the workload and requirements (Ramos, 2022).

For VFD technology to be implemented successfully, the installer/operator must understand how the system functions, the characteristics of the system, the work being completed, as well as the overall control strategy. It is imperative that the installer of this equipment understand how the system worked before the drive is installed as well as the effects that it may have on the system after installation.

Awareness of Energy Efficiency and Global Warming

The early 1970s brought about the awareness of the United States' reliance on oil and saw an increased concern over our long-term energy strategy. Many grew worried about the availability of oil for use in transportation, manufacturing, and heating. The 1970s saw many residences and some commercial facilities being built with resistance electric heating. Interest in nuclear power, as well as concerns over safety, became paramount. Energy leaders at this time seem to have expressed concern about future generations, but that concern was less related to a potential global warming epidemic and was more focused on a limited fuel source.

In 1988, the United Nations Environmental Programme (UNEP) acted and created the Intergovernmental Panel on Climate Change (IPCC) which met for the first time in November of 1988. There had been subsequent meetings which resulted in the United Nations Framework Convention on Climate Change (UNFCCC) which by 1992 had signatures from 158 states. The later Kyoto Protocol adopted in 1997 "aimed to reduce the industrialized countries' overall emissions of carbon dioxide and other greenhouse gases by at least 5 per cent below the 1990 levels in the commitment period of 2008 to 2012." (Jackson, 2007)

The northeastern United States has historically had some of the highest energy costs and hence has pushed to find efficiencies wherever possible. The voice of the end user has begun to change. While payback and return on investment is still commonly mentioned, GHG and carbon reduction goals have more recently dominated the conversation. It is refreshing to see more companies taking the initiative to have GHG goals as a major part of their future. Energy professionals must continue to impart their skillset onto the new generation in order for us to collectively support the industrial sector.

The New Energy Professionals

As one can see, there is a lot for a new energy professional to learn and it is unlikely that any formal education would provide them solutions for all these topics. Figuring out a career plan is an overwhelming task and ironically, many of our fellow energy professionals came to the industry from other pathways. Some come to the table straight out of college and others out of the trades, while some arrive with a combination of backgrounds. While it may be argued that a technical hands-on approach provides a more intimate understanding of the systems and their operation, each person's experience provides a unique perspective on energy efficiency.

I conducted interviews with recent graduates of both engineering and sustainability programs, in parallel with my work with the Southern New England Industrial Assessment Center. Many applicants are bringing a college degree with a sustainability focus; although the term "sustainability" seems to be integrated into many facets of today's collegiate programs. The concern is that sustainability credentials are being included without providing a deep enough dive into the actual subject.

In conversations with a recent graduate from Eastern Connecticut State University (Sustainable Energy) and another from Cal State East Bay (Environmental Studies), it was fascinating to see the broad swath of information received in these programs. The curriculum ranged from environmental policy to renewable energy sources, but both noted that while they had the opportunity to spend a day in the mechanical rooms of their respective schools, there was little information that was discussed surrounding building systems efficiency. It should be noted that both graduates did share that they would have been very interested if such a class was available. They also expressed that they were not aware how they would be putting their college degrees to work regarding the specific application.

It has become apparent that many students are not being made aware of the importance of a "boots on the ground" approach to energy efficiency. While the importance of global GHG reduction is paramount, energy efficiency leaders should be stressing that progress is going to be made one facility at a time. Becoming a subject matter expert takes a significant amount of time and dedication but is a very fulfilling career path that some young adults may not be aware of.

I had an opportunity to speak with an energy engineer who graduated from The University of New Haven in 2017 with her bachelor's in mechanical engineering and received her master's in mechanical engineering in 2019. It was intriguing to discuss how her training received was broad in scope, but building systems was not a significant focus. She explained that her master's thesis was written on fault detection systems in packaged rooftop HVAC equipment, which is an interesting topic, but what got her there? While working as a research assistant, she received a Department of Energy grant, and it allowed her to use some of her research work toward the completion of her master's program. As noted earlier, very few professionals start out with energy efficiency in mind, it usually finds us through fortuitous circumstances.

Discussions with another energy engineer who completed her bachelor's in mechanical engineering from Fairfield University in 2022 found that much of her educational focus was around internal combustion engines and aerospace. It should be no surprise that many of the professors in Connecticut-based engineering programs have such a strong aerospace background. However, with the exception of a brief review of refrigeration and heat pump technologies she benefited more from her LEED trainings regarding building systems.

These discussions started to indicate a trend around incoming technical expertise. Was it possible that the Connecticut Technical Education System (CTECS) offers programs that would provide a more directed approach to building systems and energy efficiency? After initial review, the trades offered in these programs included: electrical, heating and cooling, plumbing, sheet metal, and barbering (CTECS, 2023). Initially disappointed with the offering, I decided to look more into the courses that are being provided and their applicability to the industry.

In the electrical trade courses, it was refreshing to see that topics such as electrical theory and code as well as motor controls, semi-conductors, logic circuits, motor and generator theory, and power distribution and load calculations were all part of this curriculum. The heating/cooling courses included HVAC math, international mechanical code, oil burner fundamentals, refrigeration, heating, and air conditioning as well as hydronic and steam systems. The classes continued with system servicing and EPA refrigerant standards (CTECH,2023). These topics are critical to the energy efficiency expert who is working onsite and desiring to make buildings more efficient. While not able to review the subject matter or sit in on any of these classes, it is good to see that the servicing of equipment and several theory classes are noted as covered topics. The ability to understand the theory of these crucial systems allows one to service and thereby improve them if possible.

After review of the curriculum from the vocational track, it begs the question: Are students in the vocational/trade education system aware of how their training could be used toward energy efficiency? While having technical knowledge in electrical or HVAC is a great starting point for a career, is it being made clear to these graduates that there are opportunities for them in the energy efficiency auditing and reporting, building operation, or campus-wide facility management?

There have been challenges throughout the skilled trade industry. In 2022, Stanley Black & Decker, a Connecticut based company, completed a survey examining the perspective of skilled trade careers in the United States. "The skilled labor shortage is one of the biggest challenges facing the U.S. economy, with 650,000 open jobs in the construction industry alone," said Stanley Black & Decker CEO Jim Loree. "This problem existed long before the pandemic but has certainly been exacerbated by it" (SB&D, 2022) For many years, past generations have stressed the importance of a college education which may have dissuaded more technically savvy individuals from choosing a career in the trades or skilled labor. Their survey found several interesting points:

- Most students think skilled trades are a good career option, but just 16% are very likely to consider it.
- Most young people have outdated perceptions of the trades; 89% of workers said they work with cutting-edge technology and 94% say that their jobs are in high demand.
- 58% of young people have never talked meaningfully to a skilled trades professional about career opportunities.

They also noted a significant discrepancy in gender representation. "When asked if a skilled trade career sems like a good option for them. 69% of boys agree, but only 52% of girls agree (SB&D, 2022).

Bridging the Gap

Seeing that there are challenges facing our incoming workforce, how do we better prepare them for a career in energy efficiency? For many years, there has been a perception that the only way to be successful was to make a lot of money, live in a big house, go on exquisite vacations, and replicate the lives of a tiny fraction of the general population. The newer generation of workers is looking for different things in their lives. They are looking for work/life balance, fair pay, and to feel that they are making a difference in the world. A career in energy efficiency can offer the satisfaction of helping to save the planet while ensuring a steady income.

One of the first challenges facing the industry is a lack of transparency in the opportunities. As someone who has been involved in the industry for nearly two decades, I recognize an oversimplification that there are only two pathways: policy/government roles and the physical installation of equipment. There is also so much room for different personality types and skillsets and even more for those that are looking to continue their development. There are very important roles which create global energy policy and work with individual nations; there are roles for those that are inclined to work at the state level and administering efficiency programs. However, the person that is reducing fossil fuel usage by even one therm or one kilowatt hour is also making a huge difference in the overall picture toward carbon neutrality. Within the spectrum of energy efficiency, there is a home for anyone that is looking to make a difference.

Energy efficiency professionals need to be more vocal about their daily functions. If someone likes the variation of being at a different site every day working either by themselves or with a small team, there are opportunities for that. There are opportunities for those who are looking to have a more hands-on approach, bringing their tool bag with them to a site or those that are more comfortable programming and diagnosing systems with a laptop or tablet. If an individual is looking for a more fast-paced lifestyle, project management or energy efficiency consulting could be a good fit for them. The ability to talk to a customer and help them to understand how to achieve a GHG reduction goal or to build a roadmap toward carbon neutrality is indispensable. As energy efficiency can be an overwhelming topic to the layperson, a professional can take on a consultative role and make their customers feel at ease with a better understanding of the situation, much like a doctor, but for “sick” buildings.

Getting the word out to students early on should be the utmost priority. Involving kindergarten through high school students in energy efficiency projects and environmental concerns is so important. In the way that we prepare the next generations to be financially responsible, we need to train them to be responsible with the limited resources we have on this planet. Making them aware of how their actions affect the planet will allow them to be more cognitive of their carbon footprint.

Providing high school and trade school students facts about how many residences will need to be brought up to energy standards in the next couple decades should be an eye-opening experience for them. According to a 2009 Residential Energy Consumption Survey, the North American Insulation Manufacturers Association (NAIMA) has estimated that roughly 90% of all existing US homes do not have enough insulation (Goodman, 2015). That equates to 126M homes as of 2020, according to the US Census Bureau. Sadly, the condition of most manufacturing facilities is even worse. There is so much work that will be completed over the remainder of this century in the energy efficiency world. Putting together programs for young people that are both trade-focused or college bound should be a priority.

During the Fall and Spring semester of 2022/2023, Eversource Energy Efficiency employees were introduced to the senior class of engineering students at the University of Connecticut. The program allowed for a sponsorship and guidance for four students in their senior design projects. The team was comprised of two mechanical engineers and two electrical engineers, and the project was the completion of a digital twin and modeling of the Innovation Partnership Building. The team worked together, going through the electrical and gas usage of the facility and the students built an in-depth model of the facility using various simulation tools. The students would meet with the professional advisors and the department chairs to work through problems and discuss their theories. The project turned out well and as planned, discovered numerous flaws in the existing operation of the building and brought to light new ideas for ground source heat pump installations and a solar project. Eversource is again looking to sponsor another group of seniors for the 2023/2024 years. The first group would continue the work of the previous team with the digital twin, but the Industrial/Manufacturing team at Eversource is working with the Southern New England Industrial Assessment Center with the hopes of sponsoring a second team. The goal of this initiative would be to find an aged manufacturing facility in Connecticut, reviewing the site for building and manufacturing efficiencies that will continue our study into workforce development. The concept of finding young professionals that are still searching for their career path and introducing the many facets of energy efficiency is paramount to growth in the industry.

In conclusion, the energy industry is competing for young professionals to take on the roles of its continually evolving needs. Most industries are also having difficulties finding new employees, but the fulfilling nature of energy efficiency needs to be demonstrated to increase interest in this fascinating career. There is room for people coming directly out of high schools, trade schools, and colleges with varying levels of degrees. As the need for energy efficiency professionals increases, we must look to provide training and a career path for the next generation. There will be need for workers doing building envelope repairs, energy audits, project management, process optimization, and national or global energy policy. The task of training this incoming crop of energy professionals is on us and needs to be addressed now if we intend to meet the aggressive goals being set upon us to avoid catastrophic environmental damage.

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