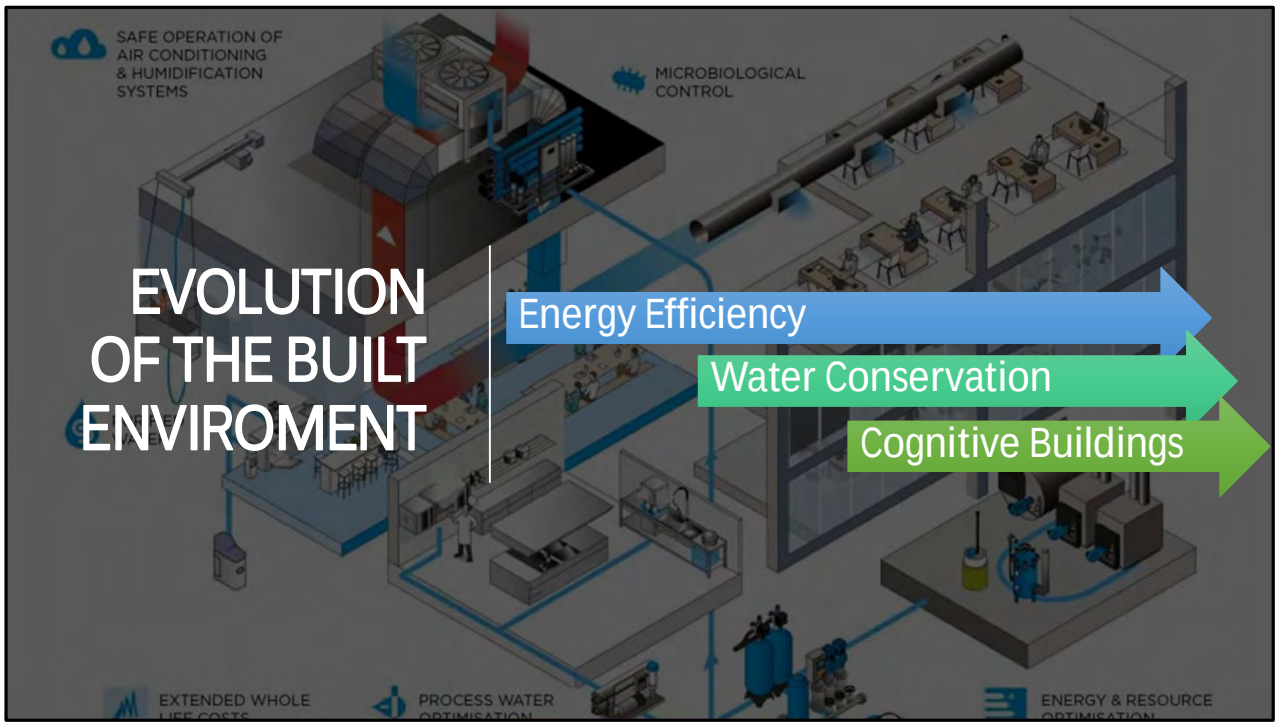
Welcome to this conversation on "The Impact of High-Performance Infrastructure". I wish to thank WPC Chair, Mr. Tom Bigley, for this opportunity to discuss such an important world-wide initiative. Wind and solar will always be the headline, but heat transfer strategies are the only scalable solutions ready for immediate implementation. Every day advanced water heating systems are being installed. Steam and hot water grids are being redesigned without fossil fuels to transfer heat between buildings, and hydrogen generation, distribution, and hydrogen appliances will revolutionize the future.

The nexus of public health, sustainability, and opportunity have created the perfect storm to energize every stakeholder's business strategy. Legislation in several states will incentivize efficient management and high-skilled labor in this environment. In the US, the UA International Training Fund has registered three additional crafts with the US Department of Labor to accelerate the deployment of appropriate skillsets.

Let's first take a few minutes to describe the cultural, technical, and practical ideologies that have evolved in the built environment for the past fifty years. In 1974 chemist Frank Sherwood Rowland of the University of California, Irvine and his post-doctoral student, Mario J. Molina, suggested that long-lived organic halogen compounds, such as chlorofluorocarbons (CFCs), could reach the stratosphere where they would be dissociated by UV light, releasing chlorine atoms. Rowland & Molina began a planetary transition to environmentally safe refrigerants. This eventually led to creating high performance building standards for saving energy and conserving water. Along the way, all stakeholders were challenged to learn, unlearn, and relearn core elements of building operations.



Energy Efficiency

For more than a generation energy consumption has been measured and monitored. As a society, once we know the number and, more importantly, the annual cost tied to that number we work to reduce the audited numbers. This resulted in a manufacturing upheaval to move the needle to the highest efficiencies possible. The manufacturing and engineering communities have responded by increasing fossil fuel burners efficiency rates and optimizing every component in all building systems. Compared to our grandparents, we now live in high-performance buildings.

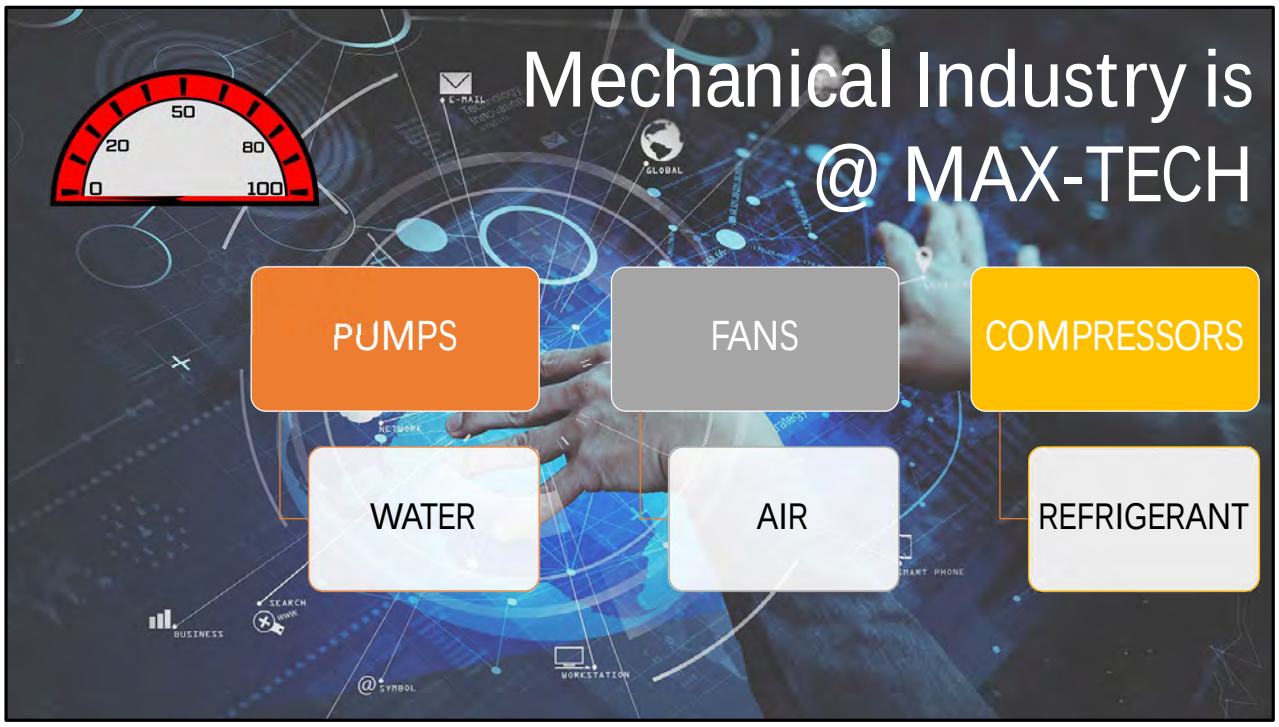
Water Conservation

Energy conservation led us to saving water consumed by the plumbing fixtures. Additionally, energy was conserved by lowering the hot water temperature to around 120 deg F. In today's environment a balance should be struck between water age, water temperature, and water quality.

Cognitive Buildings

Cognitive buildings are the next generation of sustainable building systems as they automatically integrate, analyze and learn from the vast amount of Internet of Things (IoT) generated data within a building and its environment. As a result, the building itself becomes an assistant and strives to improve user satisfaction, driving down costs and enabling new innovative collaborative services. The development of Cognitive buildings is made possible by the recent advancement and convergence of multiple technologies.

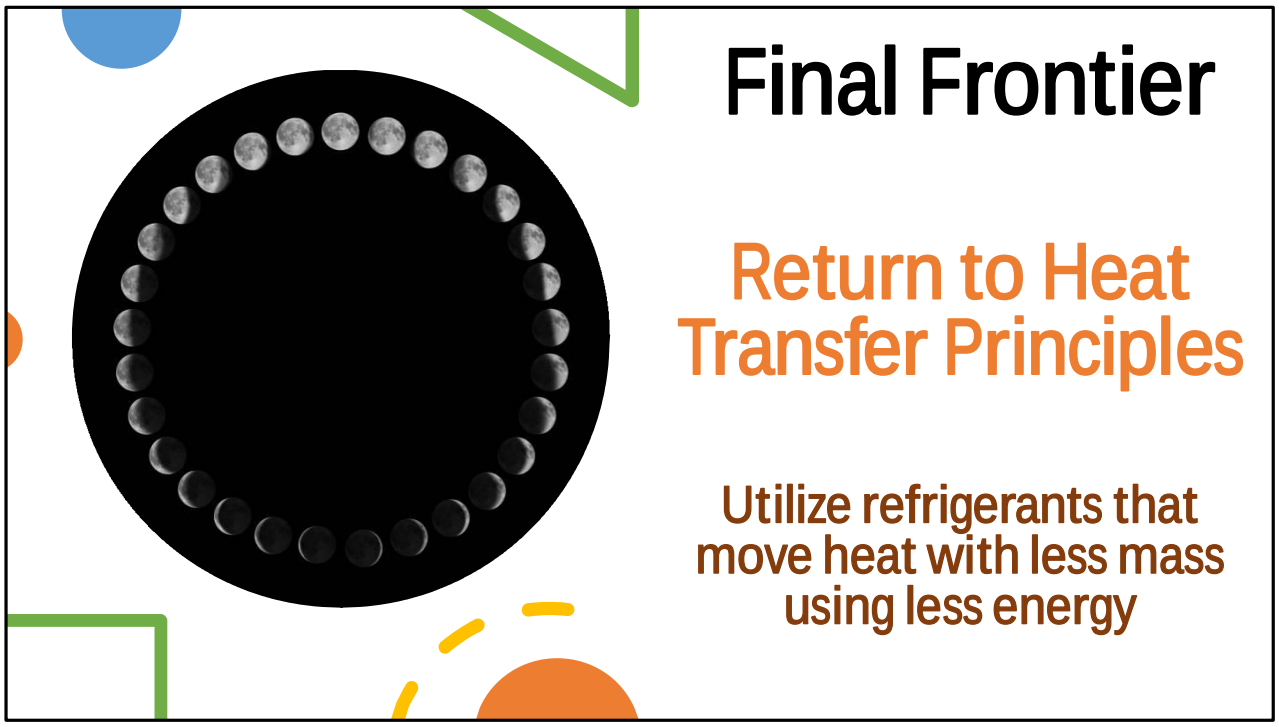
With all of the technology intrinsic to our built environment, heat transfer is the irreducible piece of the operational puzzle. All buildings are engineered with control measures to conserve water and reduce energy consumption. The universal laws of physics maintain that heat can only flow in one direction – to cold.
The manufactured products for compressor bearing systems are now at max-tech.



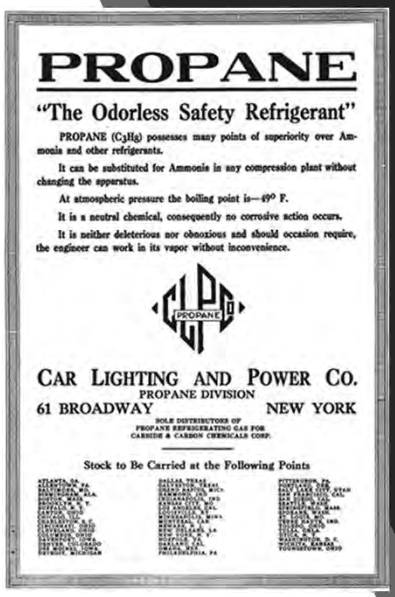
Physicist Mark Mills will tell us, “Engineers are really good at making things better, but they can’t make them better than the laws of physics permit”.

Heat will flow downhill by itself. No material on the planet can prevent BTU’s to move from the warmer to colder circumstance. Three devices move three mediums uphill throughout the built environment. Pumps, fans, and compressors convey: water, air, and refrigerant. Variable speed controls direct every component to follow the occupant load profiles by increasing or decreasing their motor speeds. Fossil fuels are metered into equipment for to match the selected speed of the fans and pumps.

By the end of this exchange, I hope to expand our understanding of “heat pumps” to include all methods of heat transfer.



Current trends in refrigerant selection by equipment manufacturers' reveal a "back to the future" reflection. To further optimize compressor energy OEM's circulate less mass through the system.



PROPANE

"The Odorless Safety Refrigerant"

PROPANE (C_3H_8) possesses many points of superiority over Ammonia and other refrigerants.

It can be substituted for Ammonia in any compression plant without changing the apparatus.

At atmospheric pressure the boiling point is—49° F.

It is a neutral chemical, consequently no corrosive action occurs.

It is neither deleterious nor obnoxious and should occasion require, the engineer can work in its vapor without inconvenience.

CAR LIGHTING AND POWER CO.
PROPANE DIVISION
61 BROADWAY NEW YORK

SOLE DISTRIBUTORS OF PROPANE REFRIGERATING GAS FOR CARBIDE & CARBON CHEMICALS CORP.

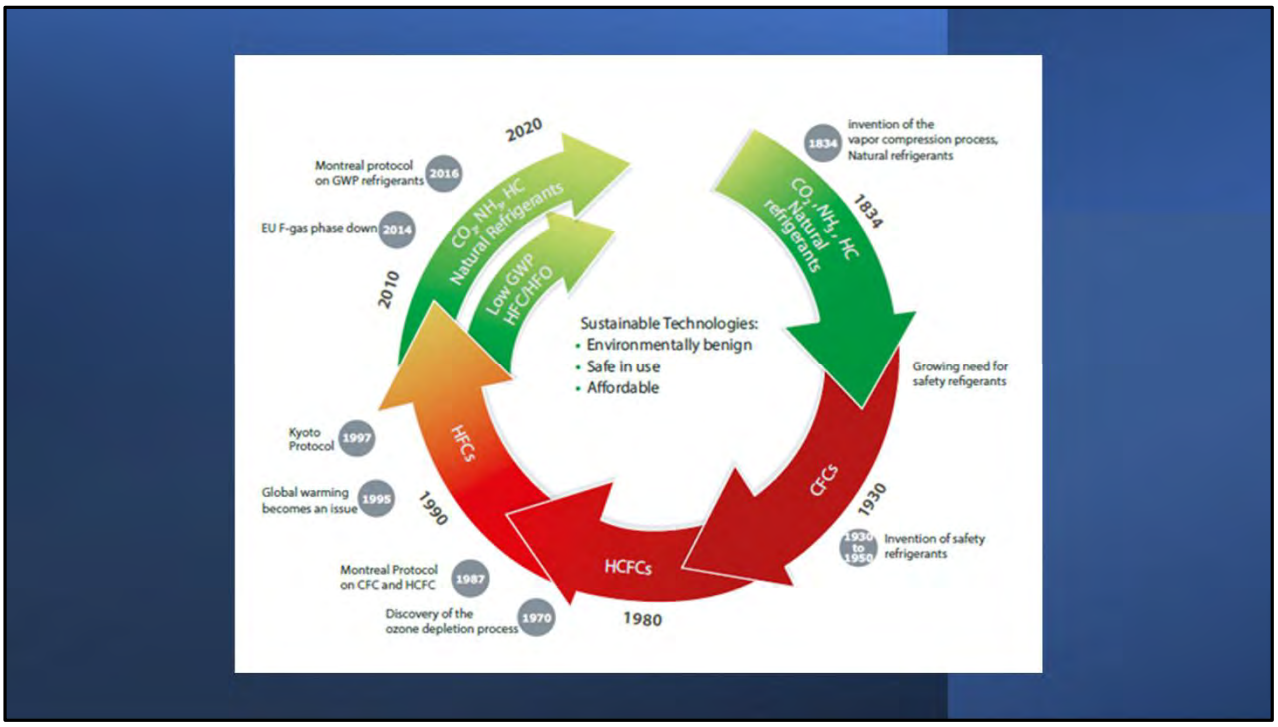
Stock to Be Carried at the Following Points

Early Heat Transfer

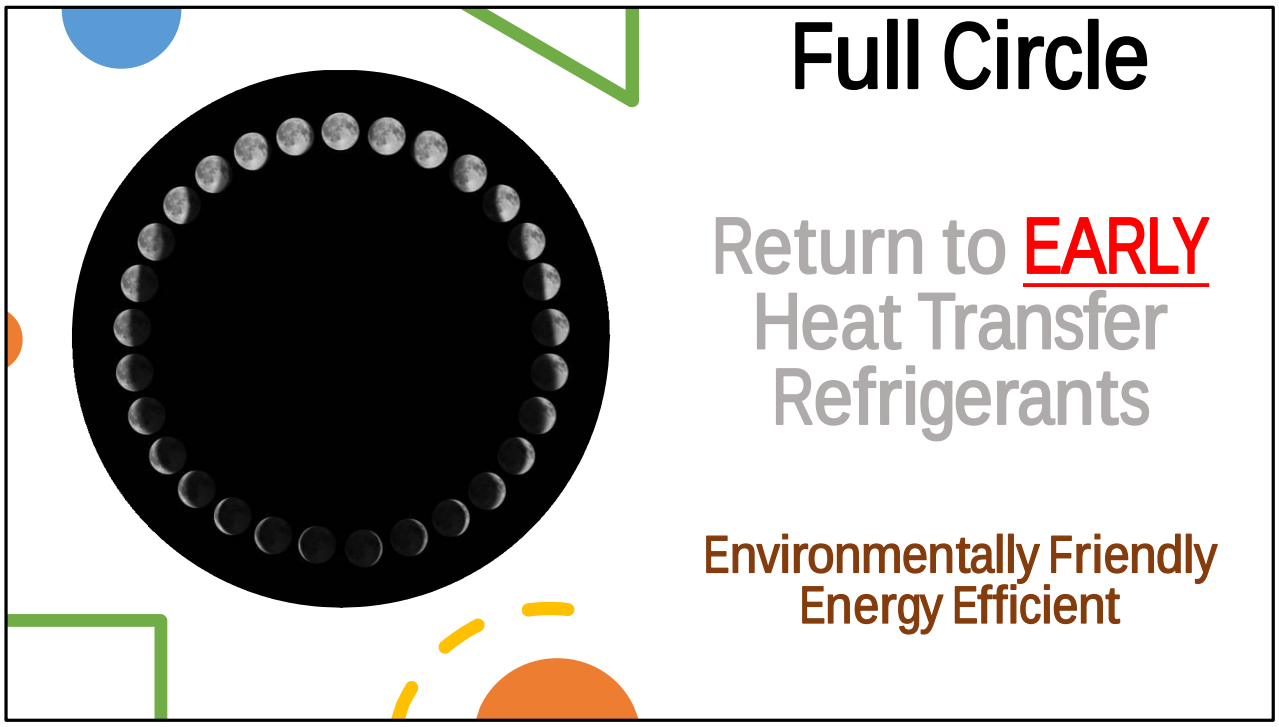
Early commercial and domestic refrigeration used ammonia, carbon dioxide, methyl chloride, sulphur dioxide, propane and isobutane as refrigerants.

This is an advertisement for an "odorless safety refrigerant" from the early 1900's. Propane was introduced as a substitute for Ammonia and used as a "drop-in" heat transfer medium.

Today, propane is being re-introduced as an environmentally safe refrigerant and marketed as a mildly flammable refrigerant.



This graphic illustrates the evolution of heat absorbent chemicals. Until today, a refrigerant is the medium that moves heat from where we don't want it to where we don't care. The mass of the refrigerants is weighed in pounds. What if a medium was available for heat transfer that has less mass than the refrigerant now being pumped through legacy systems? Why not circulate grams of refrigerant in lieu of pounds of refrigerant? Less compressor horsepower and energy? Redesign indoor and outdoor coils to trade heat more efficiently. Retrain technicians and first responders to work safely in proximity to mildly flammable refrigerants. Buyer beware – industry stakeholders have not settled industry practice for safety sensor placement, control measures in case of a leak, or leak sensor placement responsibilities.



Environmentally friendly refrigerants capture and transfer more BTU's per pound, or should we say grams. Their Global Warming Potential (GWP) and Ozone Depletion Potential (ODP) quantities help the manufacturing community offer attractive "heat pump" solutions to building owners who strive to lower the impact to the earth's environment.

To deflect the impact of climate change we have reintroduced refrigerants that require safe handling techniques to protect the building occupants.

WHY INTRODUCE POTABLE WATER INTO A MECHANICAL SYSTEM?

OPTIMIZE MAX-TECH WITH HIGH PERFORMANCE HEAT EXCHANGE PRINCIPLES

Comfort air systems offer optimized distribution for the occupied space in the built environment. Why not apply a similar strategy to domestic water? In the US, states and utilities are incentivizing the application of high-performance mechanical systems, that utilize environmentally safe heat transfer mediums, to heat potable water.

How many of you were early adopters to the NEST thermostat? This device became very popular very quickly, but not for the reasons one may think. Yes, it was easy to install, interface with the owner was simple and straight forward, and would work with any heating and cooling system. Did this thermostat manage the variable speed components to reduce energy consumption? Did NEST decouple temperature and humidity? No. When Google bought NEST Google bought a device that harvests data right where you live. This disrupted the built environment. Major HVACR manufacturers raced to connect to other devices. Here is the disruption: Integration between platforms, at one time, was a manual “handshake” between the Johnson Controls software tech and the Carrier software tech to achieve building comfort. Today, devices connect to each other without human interface. At home, when you energize one of your kitchen appliances an internal algorithm try's to find a friend named “Alexa” or a Google Home Assistant.

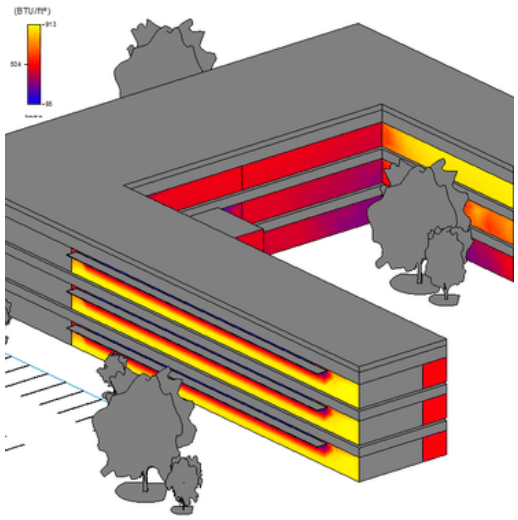
Former US Secretary of Energy, Dr. Ernest Moniz, predicted years ago, “every darn thing will be connected to every other darn thing”.

Cognitive buildings aim to take technology beyond automated processes, with a more complex and integrated approach that looks at building procedures and provides actionable insights. This combines the use of detailed facilities management capabilities and cognitive computing to promote better managed buildings.

Advancements in technology are expected to continue to make cognitive buildings more intelligent and adaptive to the needs of their occupants.

WHAT IS HIGH PERFORMANCE INFRASTRUCTURE?

- Clean Energy
- Thermal Energy Exchange
- Hydrogen Generation, Distribution, and Appliances



After a generation of creating high-performance buildings, we now move to infrastructure strategies that accelerate performance beyond the building envelope.

Clean Energy
Decarbonization
Electrification

Solar and Wind get the headlines above the fold.
Heat pump ideology is scalable, repeatable, and reliable.

All roads lead to heat pumps. All three terms refer to similar strategies to manage heat transfer absent fossil fuels.

OEM's Respond!

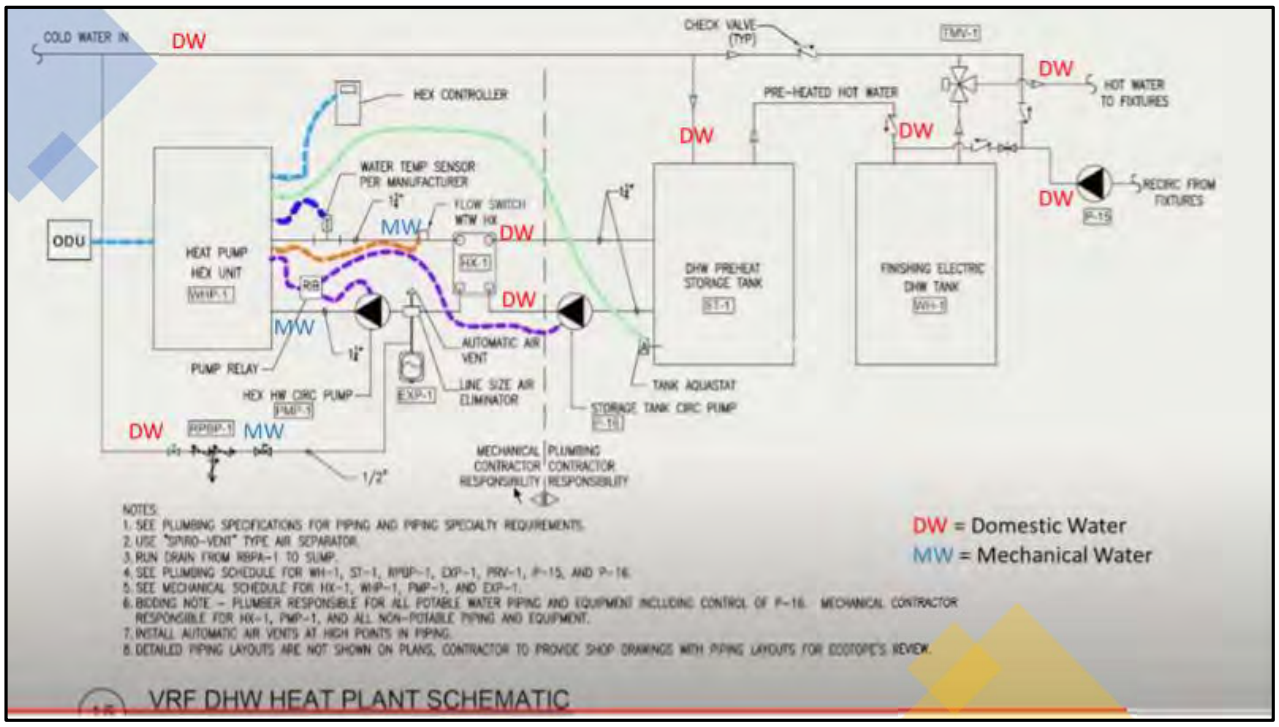
Comfort

Potable Water

Original Equipment Manufacturers' (OEM) have expanded all heat pump product families to meet the challenge for both commercial and residential applications with equipment that is mass produced and affordable.

HEAT PUMP WATER HEATER

The ideology stills uses pumps, fans, and compressors to move water, air, and refrigerant but with a twist. Potable water is now introduced into the mechanical systems as a source for domestic hot water. Each manufacturer offer their own hybrid version for general consumption in the marketplace.

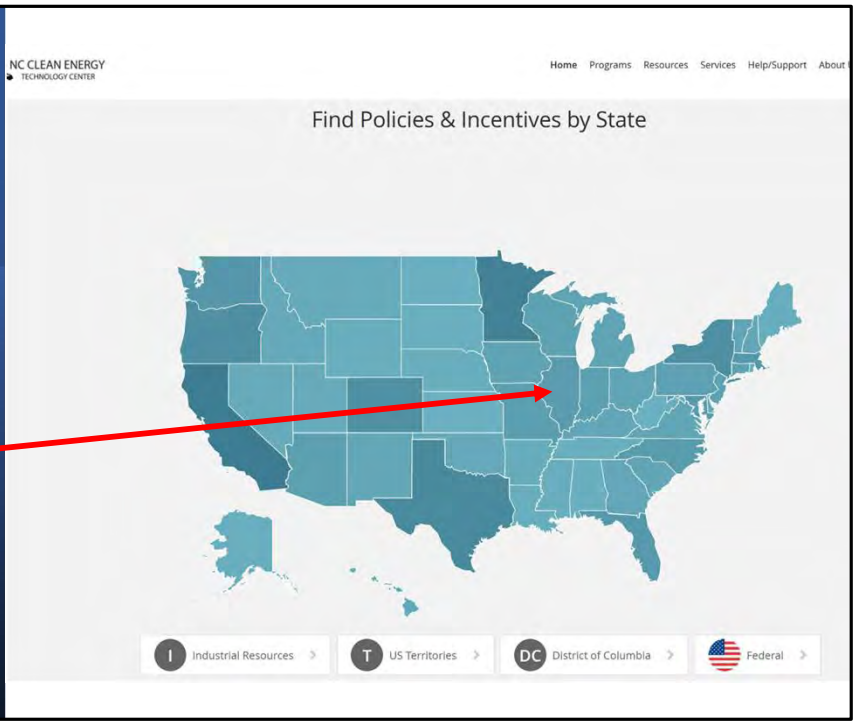


Who designs and installs this system in a way that protects public health? What impact will this have for building inspectors who delineate between “potable (domestic) water” and hydronic (mechanical) water? Which building permit is appropriate for this configuration? All good questions.

Follow the Money.....

dsireusa.org

ILLINOIS: More than 20 programs released in 2021!



In the US, clean energy is incentivized at the federal, state, local, and utility level. Opportunities vary from state to state.

Federal, State, Local, Utility Incentives:

Follow the $$$.....

dsireusa.org

Some funding is reserved for creating a high-skilled labor workforce. To instill consumer confidence New York and Maine pay for the technician training.

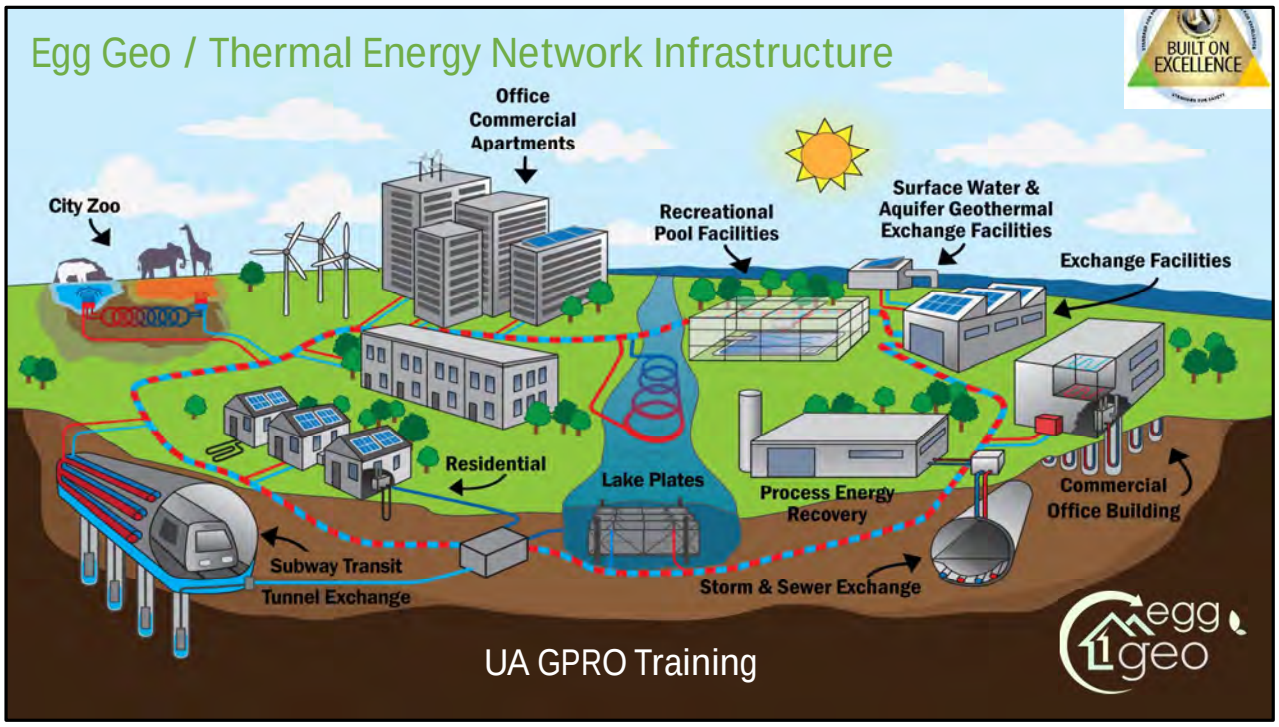
NYSERDA Program

NORTH PARK INNOVATIONS RECEIVES FUNDING AWARD FOR CLEAN ENERGY TRAINING

October 22, 2019, Ellicottville, NY – North Park Innovations Group, Inc., a woman-owned, small business in Ellicottville, NY, today announced it received a clean energy training award from the New York State Energy Research and Development Authority (NYSERDA) to help address the increasing demand for skilled workers in the state's rapidly growing clean energy economy.

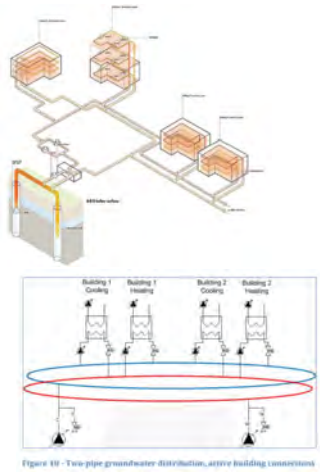
In 2019 the New York State Energy Research and Development Authority (NYSERDA) funded heat pump water heater training AND the harvesting of performance data to show compliance to the energy initiative.

Thermal Energy Networks are utility-scale infrastructure projects that connect multiple buildings into a shared network with multiple sources of thermal energy. Are you prepared to manage a “perpetual BTU”. Jay Egg of Egg Geothermal is one of the leading designers of systems that transfer heat without wasting the heat energy. For example, if you can eliminate the cooling tower, heat is not expelled into the atmosphere.



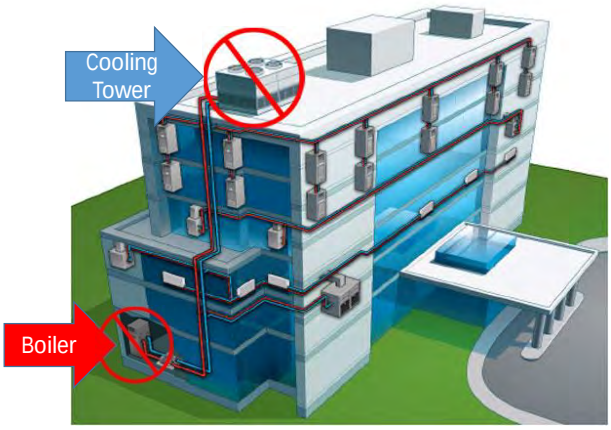
The perpetual BTU has arrived! Buildings are linked together via underground pipes. Each building is equipped with a heat pump that provides heating or cooling by exchanging thermal energy with pipes containing circulating water. The water in the pipes maintains a temperature within the needed range by exchanging heat with geothermal boreholes or other thermal resources. Recently, New York State passed legislation which: "establishes the Utility Thermal Energy Network and Jobs Act to promote the development of thermal energy networks throughout the state and to provide jobs to transitioning utility workers who have lost or are at risk of losing their employment."

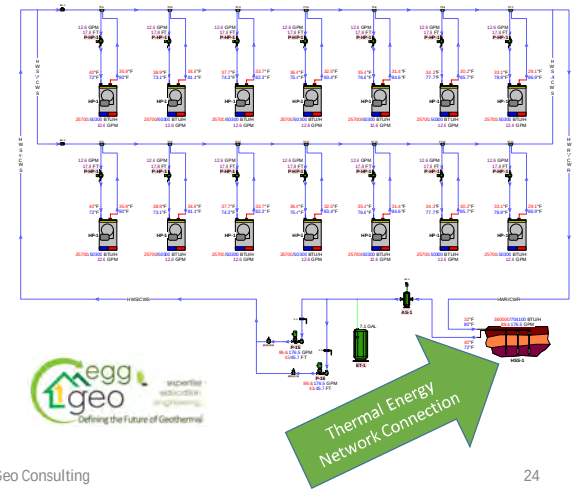
Heat Transfer from Building to Building



Egg Geothermal is busy designing pathways for the perpetual BTU to travel from building to building.

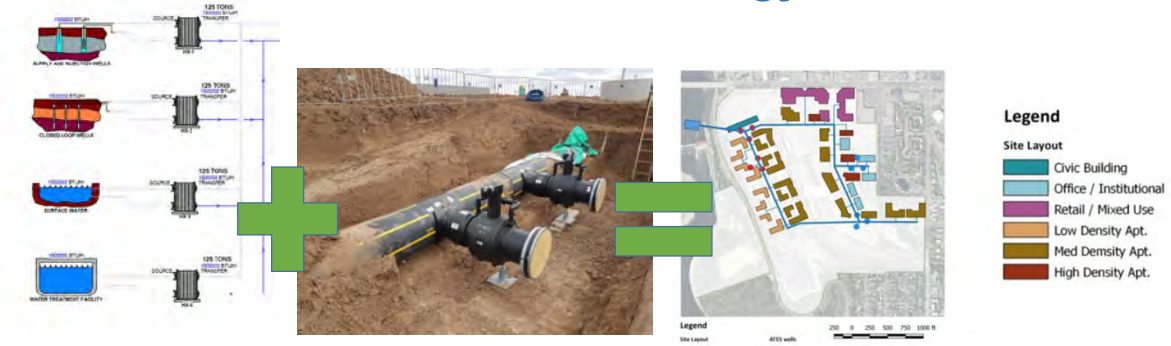
Thermal Energy Networks Eliminate Cooling Towers and Boilers





Cooling towers allow heat to be dispatch into the atmosphere outside of the building envelope.

Creation of Thermal Energy Networks

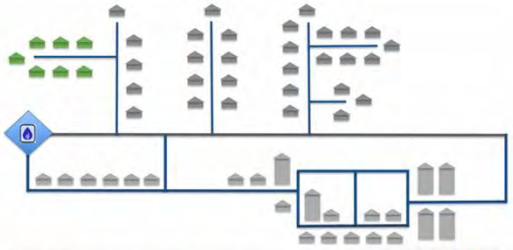


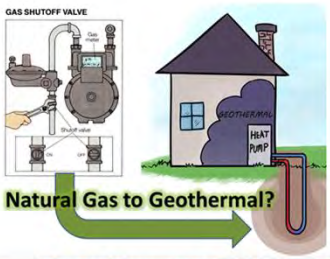
Infrastructure Sources + Horizontal Piping Infrastructure = Thermal Networks

egg geo expertise education engineering
Defining the Future of Geothermal

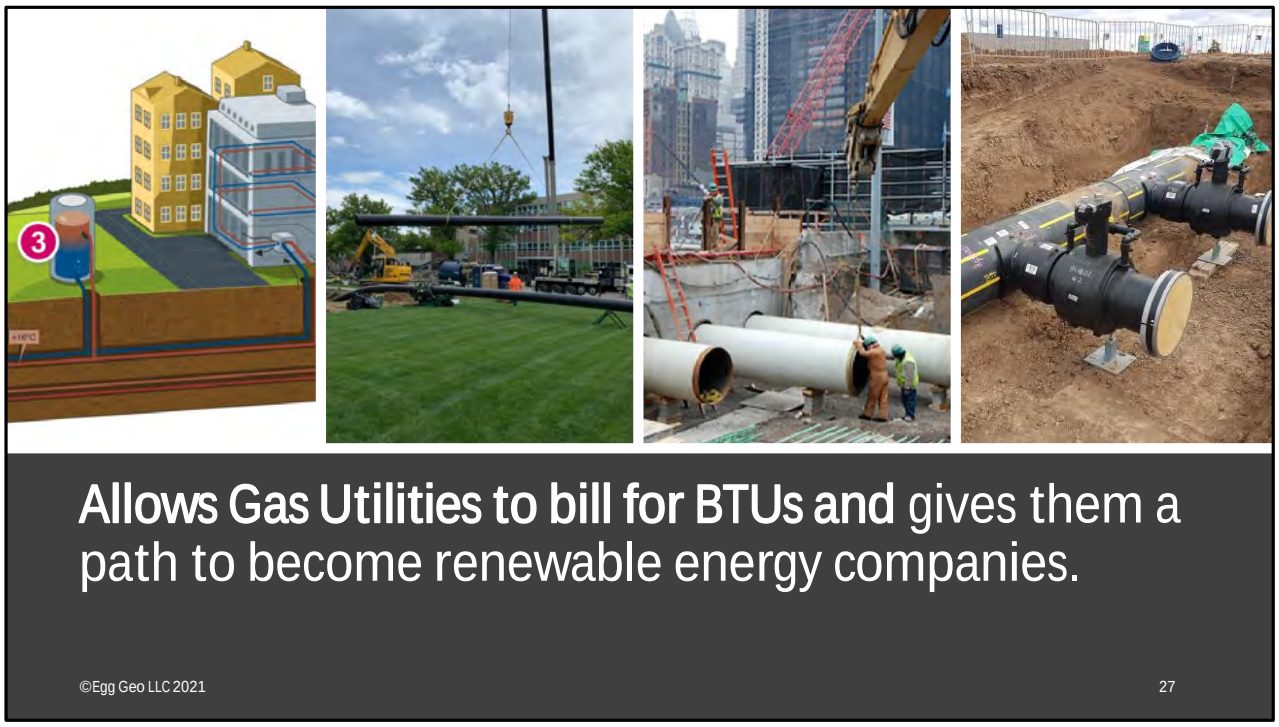
All of the requirements can be met with known technology and industry piping practices.

Industry Goals are to convert Aging NG Systems to "Thermal Micro Districts"

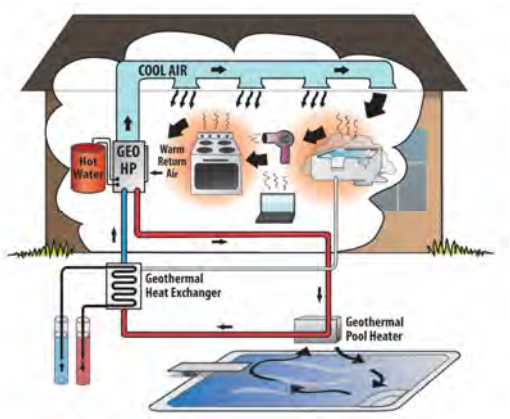


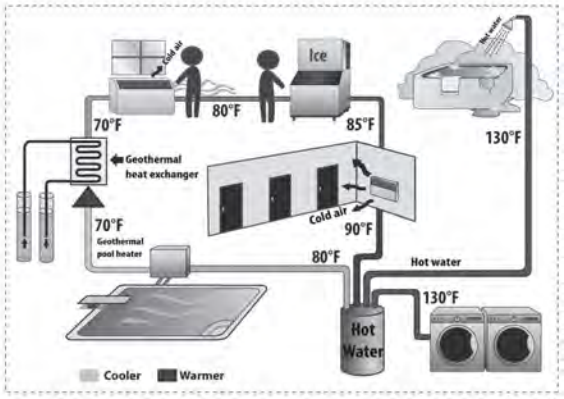


Creating a utility model may allow wider distribution and access for all communities.



John J. Murphy, International Representative United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry said, "Utility scale thermal energy networks will rapidly advance building decarbonization and reduce costs for customers with little impact to the electric grid even during peak periods while providing a just transition for thousands of middle-class workers who were at risk of being excluded from the clean energy transition."

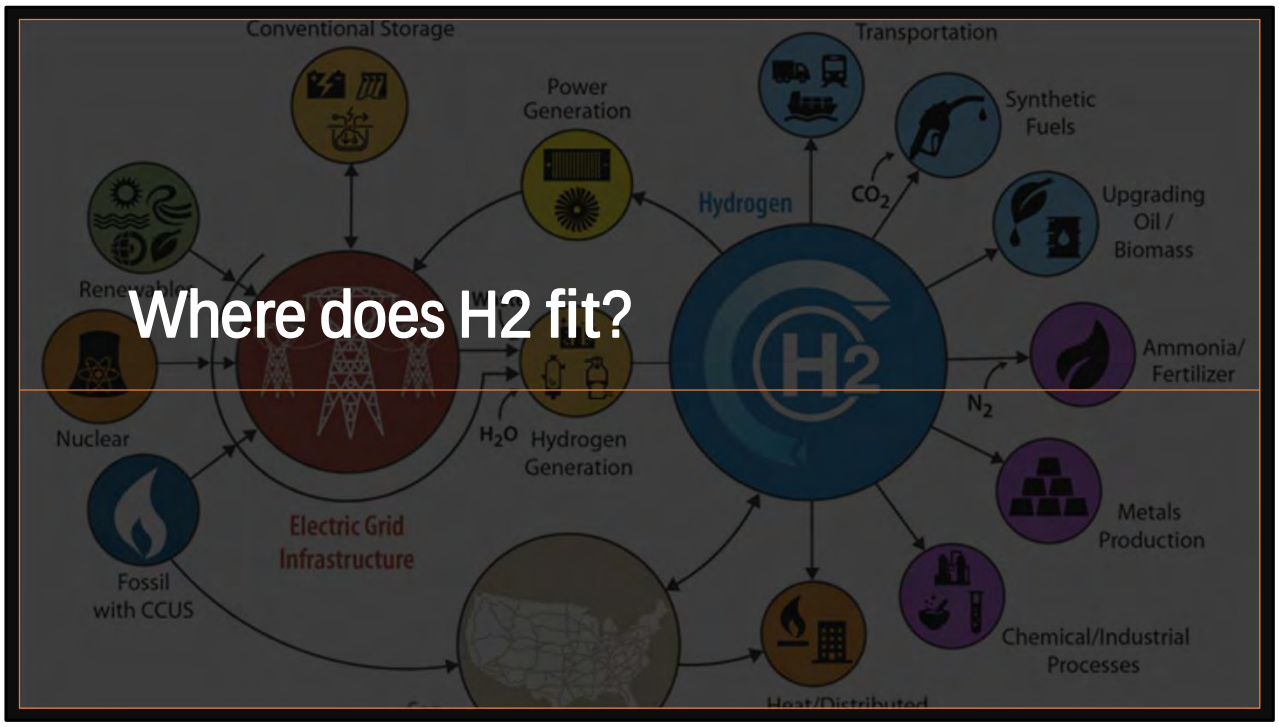




Perpetual BTUs: How Many Times Can We Re-use the same BTU? Follow the Energy…

This solution can also be applied to campus grids that already have an underground delivery system to each building.

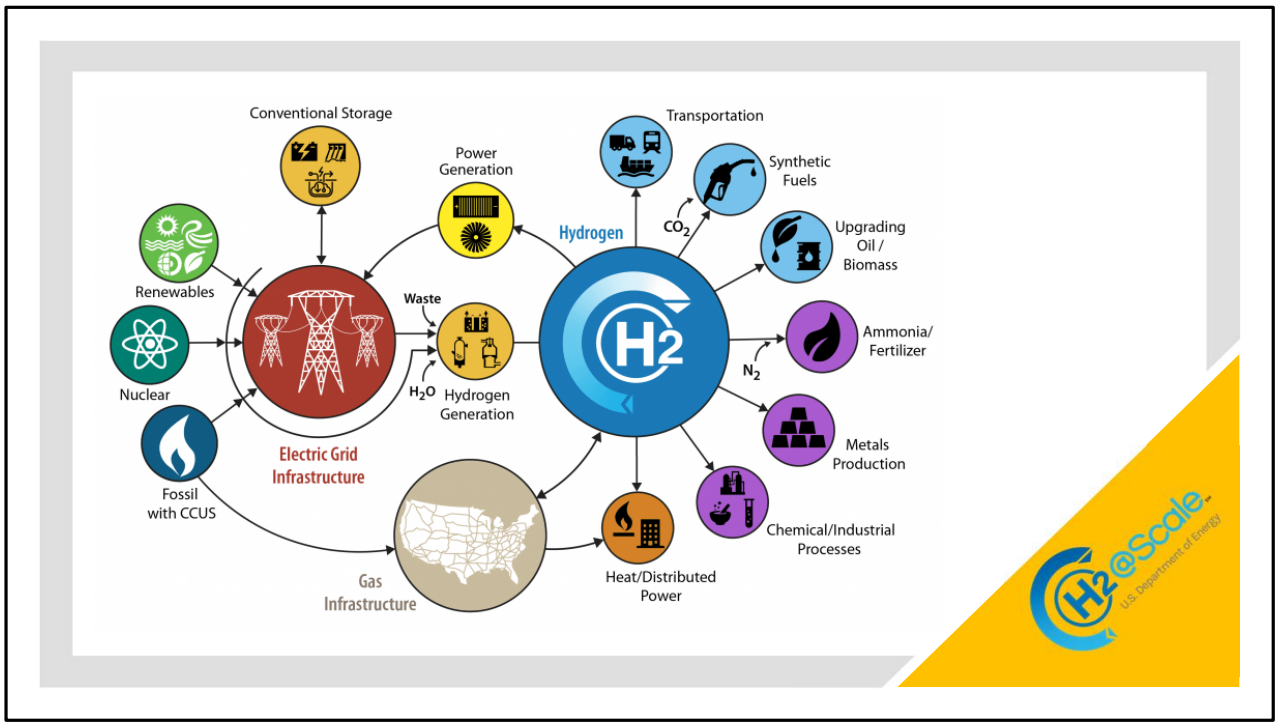
Where does H2 fit?



How soon will hydrogen be consumable?

What utility model will make it affordable?

How long before building codes can normalize access to hydrogen boilers and domestic water heaters?



Where would hydrogen fit into the modern energy system?

Just as carbon is the building block of the fossil fuel economy, hydrogen will be the building block of the clean energy economy in which renewable electricity, hydrogen (both gaseous and liquid), ammonia, and other synthetic fuels will dominate to produce, store, and move clean energy. Hydrogen's flexibility as a zero-carbon fuel, clean energy carrier, and bridge to clean electricity make it the missing piece for a fully decarbonized economy.

Long Ridge Energy Generation Project, Ohio

The Long Ridge power plant was originally planned as a gas-fired combined-cycle power plant, but the decision to convert it to run on carbon-free hydrogen was announced in October 2020.

Long Ridge Energy Generation Project (LREG) plans to develop the combined-cycle facility as a carbon-free, hydrogen-burning power plant to improve its energy efficiency and reduce its carbon footprint.

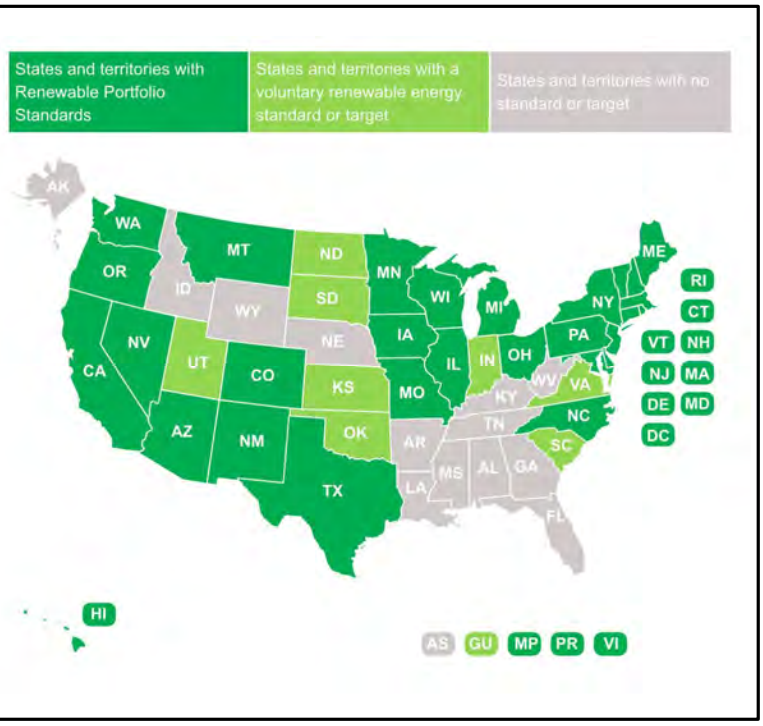
The power plant will help provide low-cost energy to Ohio. It will be the first power plant of its kind in the US to generate electricity by burning a blend of hydrogen and gas in a combustion turbine.

US Department of Energy at the Oak Ridge National Laboratory.

Codes, standards, and guidelines are being developed at this time to set up guard rails for a brave new hydrogen world. Training centers are yearning for criteria to train technicians to safely install, maintain, and service hydrogen appliances.

IECC has release electrification codes for residential and commercial buildings. Some cities have already adopted this language to be implemented in the next few years.

STATUS OF HIGH PERFORMANCE CODE ADOPTION



The dark green represents states with renewable portfolio standards.
Light green represents states with voluntary targets.
Gray illustrates the states with no standard or target.

How do all these groups synchronize their effort to unify their goals? The primary challenge lies in behavior modification and vocabulary.

If we can stop living in silos speaking shorthand to each other, we can create a system of harmonious engagement to enhance reliable and repeatable delivery of high-performance infrastructure.

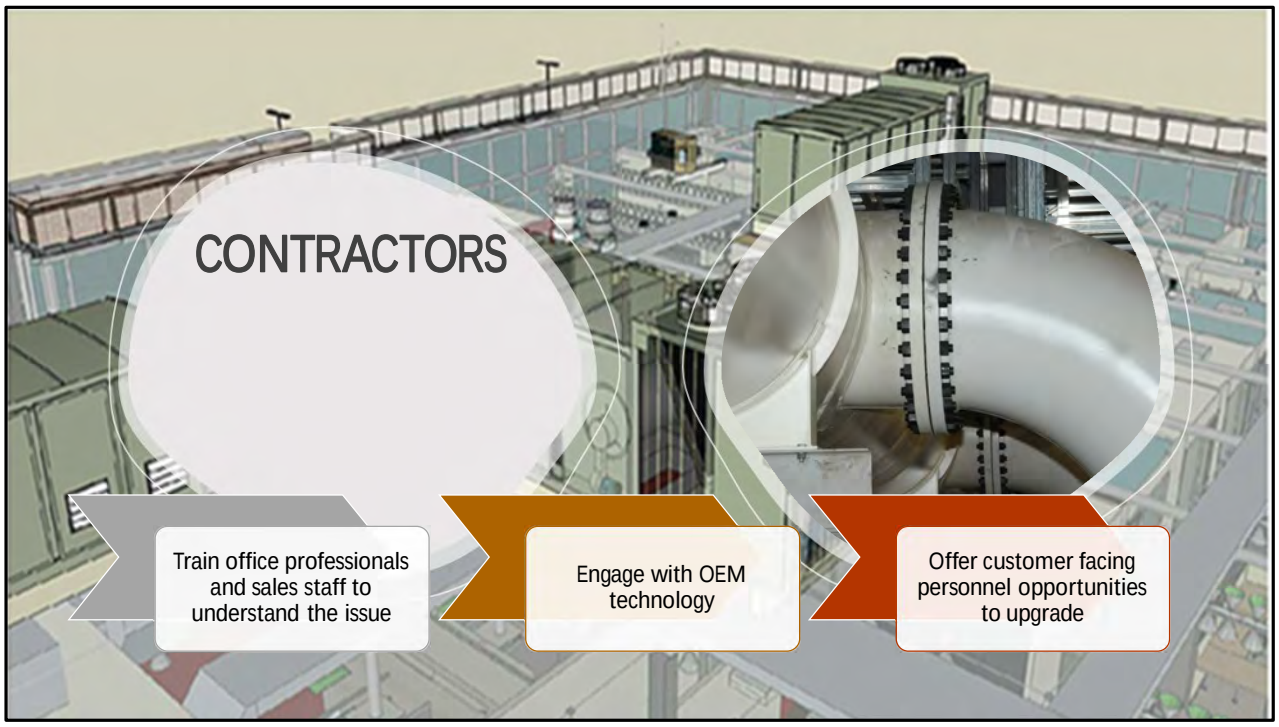
Consultants who design for progressive building owners may benefit from developing downboard relationships with local stakeholders.

INSPECTORS & AUTHORITIES HAVING JURISDICTION

When potable water is heated by mechanical equipment – is it a plumbing permit or a mechanical permit?

How about appropriate licensing?

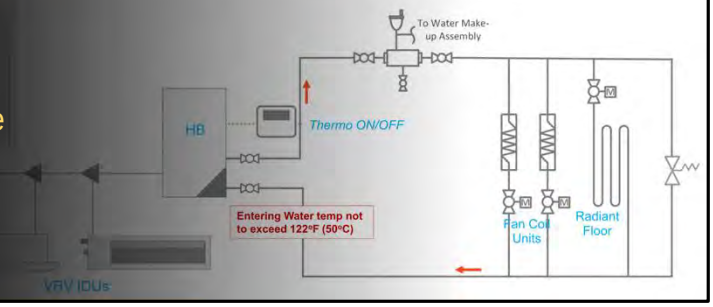
The UA International Training Fund with help from IAPMO officials are working as subject matter experts for US Department of Energy contractors to train building officials to issue permits and inspect hybrid systems.



To install, commission, service, and maintain building systems the contractors can win consumer confidence by developing an internal strategy for standardizing these projects.

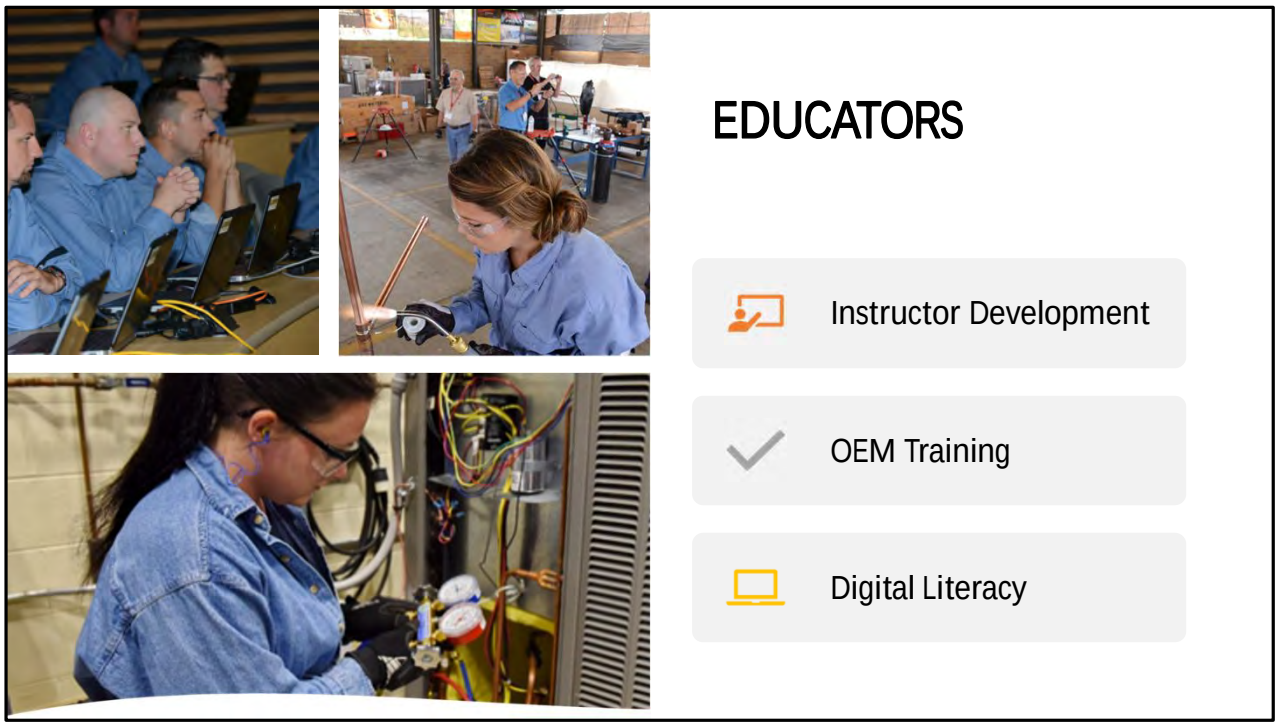
Original Equipment Manufacturers

- Increase awareness to utilities and local officials
- Promote and share training thru the distribution channel
- Stimulate consumer confidence in heat pump product families



OEM's are investing in their distribution channels to create deliverable metrics for this expanding market opportunity.

For example, Daikin North America is investing heavily for appropriate training for plumbers and HVAC technicians.

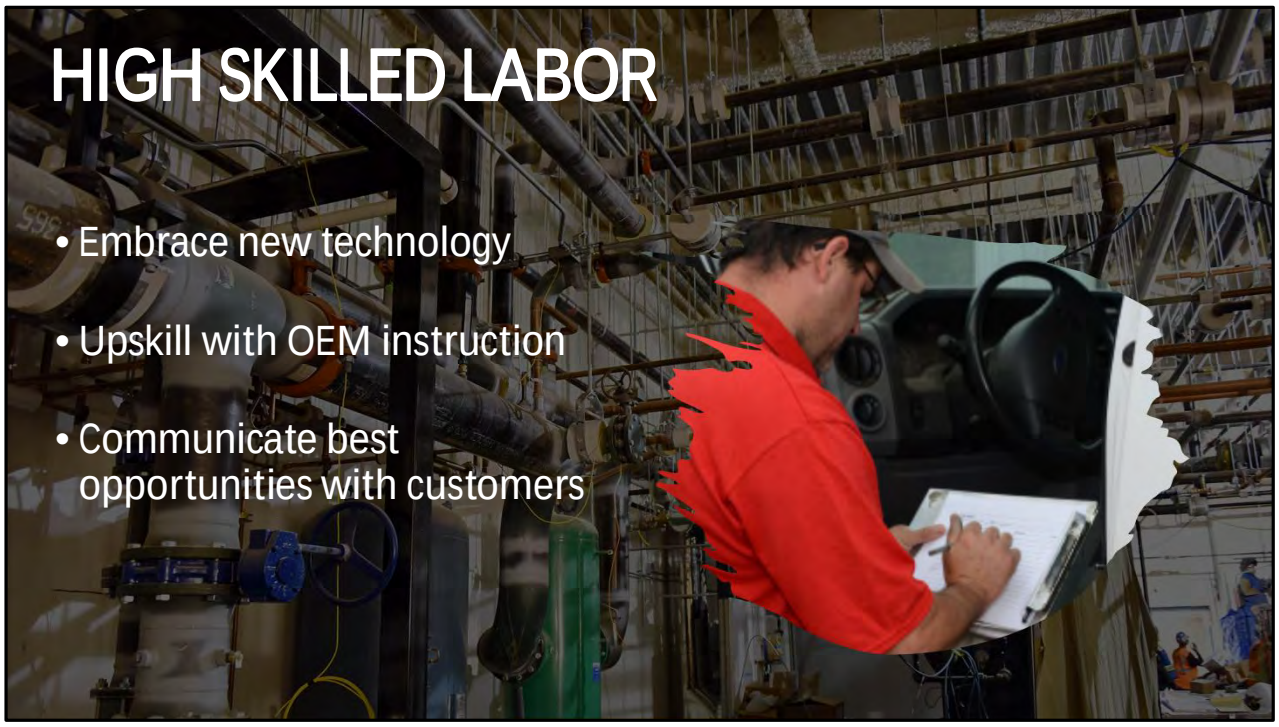


A core element for successful transitioning into high-performance infrastructure is a high-skilled workforce.
Strategically plan on getting the right information at the right time, of the right quality, to make the right decisions.

Instructors need to engage to align OEM training with heat transfer principles.

Developing your critical thinking skills is essential when you're confronted with so much information in different formats – searching, sifting, evaluating, applying and producing information all require you to think critically.

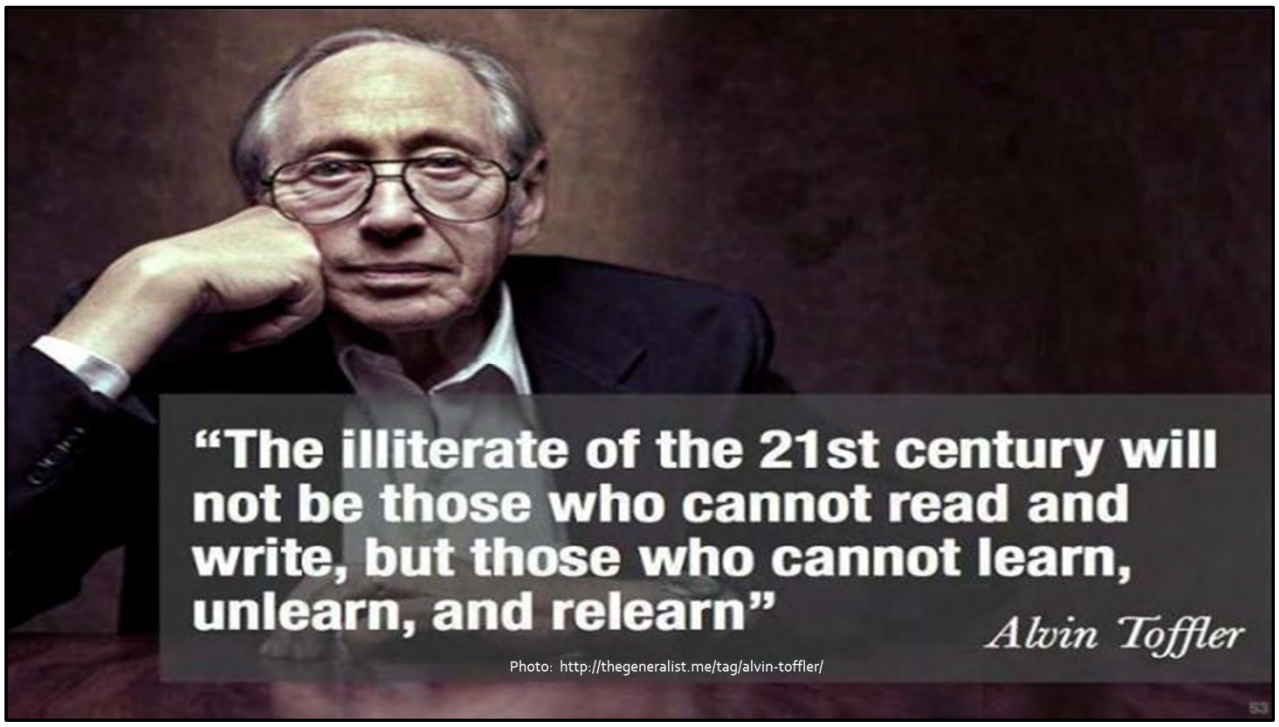
Communication is also a key aspect of digital literacy. When communicating in virtual environments, the ability to clearly express your ideas, ask relevant questions, maintain respect, and build trust is just as important as when communicating in person.



In a recent FORBES article Mark Cohen asks the reader a simple question: Why has upskilling suddenly become so important?

Short answer: digital transformation.

The digital economy, enabled by astonishing advances in technology, is reimagining the provider-customer dynamic and transforming how goods and services are bought and sold. Customer-centric, tech-enabled, well-capitalized, new model providers are disrupting incumbents across industries. They share several core characteristics: a relentless commitment to improve customer access, experience, and loyalty; the efficient use of data; achieving “more with less” for the benefit of customers, employees, and shareholders; and constant improvement. Their models are built from the customer perspective, not to fit the provider economic model.



It is never too late to learn, unlearn, and relearn. This is the bedrock for participation in high-performance infrastructure projects.

Expand Your Infrastructure World

- Clean Energy – everyday work
- Thermal Energy Exchange – design phase
- Hydrogen – growth of pilot programs

Rich Benkowski
UA Education and Training Department Consultant
International Training Fund
Three Park Place
Annapolis, MD 21401

Meet the challenge where you live:

Clean Energy is our everyday work.

Thermal Energy Networks are now being designed.

Hydrogen may very well be the future for all of us!

THANK-YOU!