

2023 AEE Trade Mission Report



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The tradition of the Association of Energy Engineers (AEE) Trade Mission dates back almost 30 years. Tours led by AEE Founder Al Thumann brought AEE members around the globe to six continents and over 30 countries. Now the tradition continues as key AEE leaders and AEE members come together to travel on curated trips designed to further the mission of AEE.

AEE understands the value of connection and knowledge sharing globally. We are stronger, smarter and more energy efficient when we bring people together across borders, with a shared focus and mission around saving the energy we use in the most impactful way.

The key objectives of an AEE Trade Mission are:

- Learn about the energy landscape in other regions.
- Discover new/different energy technologies, systems, processes, best practices, ideas.
- Build new connections that bring forth critical global knowledge sharing needed to meet the challenges our industry and environment is facing.
- Promote the AEE and our members expertise within the region and globally.
- Make unforgettable memories with fellow global AEE members and AEE leadership.
- Experience profound culture exchanges.
- Establish sustainable partnerships that have a lasting impact.

The Nordic region was identified as a key area of interest for AEE given its advanced use of renewable energy practices and strong focus on ambitious climate goals. The countries in the Nordic Region include Iceland, Finland, Norway, Denmark, and Sweden. These countries have some of the highest per capita annual energy consumption in the world, and they are depending on renewable energy sources such as geothermal and hydroelectric. However, as a region they have significant opportunity to increase their



efforts in energy efficiency. The region has also been impacted recently from ceasing the import of Russian oil and gas since the invasion in Ukraine, as with the rest of Europe. The Nordic Region is one with little awareness of AEE and therefore access to the global knowledge sharing we strive to provide our members. When an entire region is not represented our membership base is not afforded the full range of expertise available in key areas of energy efficiency.

Our goal of this specific mission was to learn about the energy systems, expertise, technologies, and their approach to the energy transition and raise awareness about AEE as a professional society and our work disseminate information globally to share best practices and build the capacity of energy engineering professionals. We hope to build a base of AEE members in the Nordics and identify key partners with aligned missions to bring Nordic innovations into a global light.

A total of 15 AEE members and some spouses from the United States, Canada, South Africa, and Kuwait came together for this journey across the Nordics, to Iceland, Norway and then Finland.

The Trade Mission began in the capital of Iceland, Reykjavík City. The name, meaning Smokey Bay, was given after the early settlers saw the steam rising from the hot springs in the ground.

In Iceland, 30% of electricity is produced by geothermal, and 70% by hydroelectric power. Iceland is unique as the island lies on the North Atlantic ridge between the North American and Eurasian tectonic plates. This is a highly active geothermal zone that can thus power significant geothermal resources. There are 8 geothermal plants in Iceland. 90% of houses and buildings are heated by low-temperature geothermal fields. As they say in Iceland, “If the land is older, it’s colder.” This older land produces these lower-temperature fields that can be used to bring heat directly to homes and businesses. A substantial portion of the electricity produced, 83%, goes to industry. Ken White, AEE member and fellow traveler recounts “Currently, they produce more electricity than needed for domestic use and sell the excess to foreign corporations with facilities in Iceland.”



The very first stop was the Blue Lagoon, a bright blue glowing lagoon situated in the middle of the harshest of landscapes. With dark lava rock all around, the tired travelers enjoyed relaxing in the warm and cozy waters of the Blue Lagoon. The Blue Lagoon is a famous tourist spot with one of Iceland's main geothermal plants just next door. The rising heat from the plant reminds us that this lagoon was in fact a mistake made by condensation discharge from the geothermal power plant in Svartsengi. The water was expected to soak into the lava field however, due to sedimentation the area began to fill, and the lagoon was formed. The Blue Lagoon has a famous white silica mud that is created when the extremely hot water reaches the surface and then cools creating the white mud that the Blue Lagoon is famous for.

The first business meeting of trip was held at the Business Iceland offices in Reykjavik. The delegation was hosted by Green by Iceland, with representatives from Women in Energy Iceland and the Iceland Renewable Energy Cluster.

Green by Iceland is a platform for cooperation on climate issues and green solutions between Iceland and international counterparts. Their role is to support Iceland's reputation as a leader in sustainability on a global platform. Their vision is to inspire and create a global impact in climate actions by promoting the export of Icelandic green solutions, driving knowledge exchange, and fostering international collaborative efforts. Green by Iceland is a subsidiary of Grænvangur, a domestically focused platform that supports Icelandic public and private sectors in their joint ventures to reach climate neutrality.

The Iceland Renewable Energy Cluster is a cluster organization founded in 2013 after several years of mapping and implementation. At the beginning, it focused only on geothermal but in 2018 it was expanded to other renewable energy resources like hydro and wind. The organization is a membership-based platform of companies in the Iceland energy market building on extensive experience in the utilization of the country's natural resources, with a focus on hydro, geothermal energy, and wind. The cluster's focus is on competitiveness, innovation and the promotion of the



Icelandic energy sector and its companies. Each year they hold an international Geothermal conference. The fifth IGC2024 will take place in Reykjavík May 28 – 30, 2024.

Women in Energy Iceland is an association for women that work or are interested in the energy and utilities sector in Iceland. The association is open to anyone who considers the association's purpose relevant to their values and wishes to promote its progress. The work done by Women in Energy Iceland has raised the number of women in the industry to 40%, a significant increase in a brief period.

After learning about all the participating organizations, we had the opportunity to tour the Future Energy Exhibition, an interactive exhibit created by Green by Iceland that brought us on a journey through the Icelandic energy history, 2030 and 2040 climate goals and existing solutions to meet those goals.

Iceland has a roadmap towards a green future, that includes cutting emissions by 55% in 2030, Carbon neutrality by 2040, and fossil fuel free Society by 2040. They have two major strategies, a Sustainable Energy Policy for the year 2050 and a Climate Action Plan with 50 funded actions. The Climate Action Plan includes funded projects like the development of a hydrogen roadmap, banning of registration of petrol and diesel cars, zero emissions transportation, clean energy transition, enabling CO₂ injections, carbon capture from geothermal energy plants, doubling of land reclamation, wetlands restored and conserved, doubling of forestry, banning of bio waste in landfills, landfill tax, less food waste, carbon-neutral beef production, domestic vegetable production, fertilizers, feeding of livestock, fishmeal production plants, construction industry, carbon tax, ban heavy fuel oil, F-gases, ports electrified, heavy transport, active mobility, and public transport.

Concluding the meeting we discussed the importance of working together to share knowledge and expertise locally and globally. Following the meeting, the participants enjoyed a special welcome dinner. Following the dinner, a quick glance at the night sky displayed the magnificent and unexpected green dancing glow of none other than the Northern Lights. The group spent time together sharing this once in a lifetime experience on the shores of the smokey bay.



On day two, the delegation embarked on the Golden Circle Tour. The Golden Circle is a journey around the center of Iceland to visit some of the most magnificent sites in the country. First, we visited the Gullfoss waterfall, next the spouting hot springs of Geysir, and Þingvellir National Park, site of the Viking Parliament and over 1000 years of history. The site of the Viking Parliament is also a unique geographical setting of a rift valley in the divide between the North American and Eurasian continental plates. The lava fields are torn apart by tectonic forces, leaving gorges and fissures that look like they could be from a movie set.



Along the Golden Circle, AEE had the opportunity to tour the Hellisheiði ON Power Geothermal plant and exhibition, located in a stunning setting surrounded by lava and moss. We saw first-hand how green, sustainable energy is produced and at one of the largest single-site geothermal power plants. The plant near Reykjavik produces 303 megawatts of energy. We had a unique and exciting opportunity to learn about geothermal power and sustainable energy in Iceland. We saw the turbine halls of the plant and experienced interactive and educational displays and learned about the plant's partnership with Carbfix, a leading solution for CO₂ storage.



There are three types of carbon capture, Direct source, Mineral Storage and Direct Air capture. Carbon capture is not the solution for our climate crisis, it is just one of the pieces that can further support the 1.5-degree global target.

Carbfix was a technology created at Hellisheiði ON Power Geothermal plant just over two years ago. Carbfix is a solution to Direct Source Capture. It takes CO₂ and H₂s and injects them directly into the ground producing rock.

They are working to build a terminal, called Coda terminal in Reykjavik, that should be completed in 4-6 years where countries all around the world will ship their carbon and it will be stored in the bedrock in Iceland. From the Carbfix website, "The Coda Terminal is a cross-border carbon transport and storage hub in Iceland. CO₂ is captured at industrial sites in North Europe and shipped to the Terminal where it is unloaded into onshore tanks for temporary storage. The CO₂ is then pumped into a network of nearby injection wells where it is dissolved in water before being injected into the fresh basaltic bedrock. There the CO₂ remains trapped in the carbonated fluid and transforms into solid minerals in less than two years. Once the process is confirmed, further monitoring is not required."

In addition to Carbfix, Swiss company Climeworks is also located onsite at the plant doing Direct Air Capture. Climeworks and Carbfix have partnered to take the CO₂ from the air and embed it into the bedrock.



Climeworks states on their website that, “Our direct air capture (DAC) technology is one of the key technological solutions to fight climate change. It captures CO₂ directly from the air, reducing the atmospheric concentration of CO₂ by only using renewable energy, energy-from-waste, or other waste heat as energy sources. It’s a three-step process, 1) Air is drawn in through a fan located inside the collector. Once sucked in, it passes through a filter located inside the collector which traps the carbon dioxide particles. 2) When the filter is completely full of CO₂, the collector closes, and the temperature rises to about 100°C — about the same temperature it takes to boil water for a cup of tea! 3) This causes the filter to release the CO₂ so we can finally collect it.” You can find a recent report from the IEA on Direct Air Capture [here](#).

This tour was fascinating for all the delegates. Rich Costello, an AEE CEM and CEA instructor said, “Touring the plant and seeing first-hand and even touching the rock displayed that contains the sequestered CO₂ was incredible. What once was a fantasy solution, we were able to see and touch in person.”

At the end of the tour the guide even hinted that there has been some recent discussion about duplicating the “accident” that formed the Blue Lagoon there at the Hellisheiði ON Power Geothermal plant. Given its proximity along the Golden Circle tour route, this would be a well-positioned location for a new lagoon in Iceland that would be worth a visit.

On day three of the mission, we discovered West Iceland, where some of Iceland’s best-known Sagas took place. Heading out of Reykjavik, we spent some time at Settlement Center Museum, to learn how Vikings made their initial boat journeys to Iceland in the late ninth century.

We drove through Borgarfjörður fjord towards Husafell. On the way we made a stop at Deildartunguhver hot spring. The spring consists of water boiling out of the ground in several small pools.



It is Europe's most powerful hot spring, at a temperature of 100°C (212°F). There is also a nice spa at the hot spring, since the water is too hot for someone to enjoy of course so they mix it with nearby glacier water.

The next stop was the magnificent Hraunfossar lava waterfalls. There is no direct water source for these falls, just groundwater seeping beautifully through the rocky and porous lava rock. It was a magnificent site to behold and an utterly unique experience for all the travelers.

The adventure of the day was caving at Viðgelmir cave. Vidgelmir is Iceland's largest natural lava cave, located in West Iceland. We went on an adventurous guided walk down and through this great lava cave. We learned about its history and geological uniqueness which dates all the way back to the Viking age. A little less than 1600 meters long (about 5249.34 ft) / 5250ft (about 1.6 km), the cave features amazing colors and lava formations, including "lava chocolate" that seeped from the walls of the cave dripping like chocolate and an interesting formation they lovingly and called "lava shits." The lava that formed this and the hundreds of other caves in the region came from a fissure eruption in the ninth century that lasted 3-5 years creating a river of lava melting into the surface of the earth. As the eruption slowed, so did the lava and the lava at the surface began to harden, creating this magnificent cave.



Day four, we journeyed to the south of Iceland for an all-day South Shore Tour. South Iceland is special as it is one of the flattest regions on the island. Because of that all grain farming in Iceland is done there. The high mountains to the north shield the area from the harsh winds from the north.

Among the stops on this tour are at the gorgeous Seljalandsfoss and Skógafoss waterfalls. Seljalandsfoss is part of the Seljandsá river, which has its origins in Eyjafjallajökull glacier. What makes Seljalandsfoss so famous is that you can walk behind it. Skógafoss, another famous Icelandic waterfall, is the starting point of the Fimmvörðuháls walk over to Þórsmörk. The shining sun, mist from the falls and quickly changing weather produced a beautiful display of rainbows throughout the day.

Next, we visited the famous Reynisfjara black sand beach, with the Reynisdrangar rock formations and columnar basalt. It is one of the most spectacular beaches in Iceland. It can also be one of the most dangerous. We were warned of “sneak waves” that will quickly come ashore washing away anything in their path and saw firsthand an unaware group of travelers get knocked down from their unexpected advance and force.





Along the route home, we stopped at the Sólheimajökull glacier in southern Iceland, between the volcanoes Katla and Eyjafjallajökull (part of the larger Mýrdalsjökull glacier). We were able to witness the majestic beauty of one of the last few hundred glaciers. It is widely believed that Iceland will lose all glaciers in the next 100-150 years as most have already disappeared, there are approximately 200 glaciers still left. As the glaciers have melted in Iceland the land has risen, as the pressure from the ice is gone and the ground is bouncing back.

Executive Director of Institute of Energy Professionals Africa, Yolanda de Lange recounts a powerful sense of contrasts on the trip, especially in Iceland, "I found visiting these countries intriguing as it was so cold, but all around us everything was boiling with geysers shooting up, steam coming from the earth, and volcanoes threatening. The pure white ocean foam rolling over black sea sand on the beach. Beautifully imaged sustainability goals for countries with frowns when we ask about energy efficiency. As ice melts and rolls into the ocean off these countries' land, they grow, and the others shrink due to water levels rising."



Day five, the group was sad to leave Iceland, but looked forward to the next stop in Oslo, Norway.

Founded in 1048 Oslo is Scandinavia's oldest capital and today it is a very pleasant and casual city with an interesting mixture of historical and modern architecture. Upon arrival, the group took a sightseeing tour of the Norwegian capital, beautifully situated by the fjord. We visited Vigeland Park, one of the major Scandinavian cultural treasures and were welcomed by incredible sculptures by Gustav Vigeland, who dedicated his life to his artistic works. His vision for the park and the over 200 sculptures was to show human life and all types of relationships.



On day six, the delegation visited City Hall. The location where the royal family has public appearances and where the noble prize is given out.



AEE's business meeting in Norway was hosted by at the Nordic Energy Research. Nordic Energy Research is the platform for cooperative energy research and policy development under the auspices of the Nordic Council of Ministers. They are based in Oslo together with their sister organizations Nordforsk and Nordic Innovation. Nordic cooperation in energy research started 1975, leading to common research funding since 1985 and the establishment of Nordic Energy Research as an institution under the Nordic Council of Ministers in 1999. The Board comprises representatives from the authorities and ministries responsible for energy research funding in the five Nordic countries, who contribute the majority of the organization's funding.

NER's COO, Kevin Johnsen provided a comprehensive presentation about Nordic Energy Research, energy systems in the region and some of the key projects in each Nordic country.



In the Nordic Region transport is the biggest source of GHG emissions with Industry following closely behind. Also, 40% of the energy mix is still oil/gas.

In Norway, they rely heavily on hydro-electric power. Their focus is increasing capacity, primarily through wind and solar.

Mr. Johnson shared some exciting and innovative Nordic demonstration projects by country. In Sweden, the HYBRIT® project is creating the first fossil-free steel production. It aims to bring the first green steel, 100% carbon neutral, to the market by 2026. In Norway, Hywind Tampen is a pilot project just launched in August 2023 of 11 floating offshore wind turbines in the North Sea. Denmark is currently working on a project called Energy Islands. These islands once constructed will serve as green power plants to bring electricity from offshore wind farms to Denmark and other Nordic countries. In Finland, Vantaa Energy Cavern, will be the largest thermal energy storage cavern in the world, created to store 90 GWh of renewable energy and waste heat. By storing this energy, natural gas will be replaced in the winter and therefore carbon emissions will be reduced by 65,000 tons a year. Finally, he shared about the Carbfix project in Iceland.



For additional information on the work Nordic Energy Research is doing you can access their report at “[Nordic Clean Energy Scenarios, Solutions for Carbon Neutrality.](#)”

AEE was given the opportunity to tell NEC about AEE’s work and your main focus areas. Following that, we engaged in an informal discussion about possibilities for synergies and cooperation including the upcoming Conference of Parties (COP28) in Dubai in December.

Fellow traveler and AEE member, Jerry Webb was impressed with NER’s work and the “greater Nordic focus over the individual national focus on energy sharing and programs.” He suggested a similar regional focus in these areas could serve other parts of the world where it is lacking.

After the meeting, the travelers went central station to take a 5-hour train through Norway’s most scenic fjords, including a special trip on the Flam Railway, down a steep grade through mountains and past waterfalls, arriving in Flåm, a quaint and majestic town at the end of the Fjord.

Day seven, we enjoyed the quiet and peaceful surroundings in Flåm. Later this afternoon we boarded a ferry from Flåm to Bergen. We traveled along Norway’s longest and deepest fjord: the Sognefjord, also known as the “King of the Fjords.” The mountains and waterfalls were breathtaking, but the rain kept us inside for most of this journey.



Day eight, we enjoyed a tour of Bergen, the famous Bryggen Harbor with its gabled pack houses, and the old Hanseatic Quarter. We rode on the funicular to Mt. Fløyen to access the best views of the city and fjords below, even posed for photos with the cashmere goats who live on the mountain top.

The city of Bergen set a goal to be the first carbon neutral city in Norway by 2030. They do not currently charge taxes for electric cars, and they are allowing EV's to commute free of charge on bridges and ferries and provide charging stations in most parking lots.

Later the group took a fjord cruise to view mountains and stunning waterfalls cruise to Mostraumen from Bergen. Mostraumen is a self-sustaining village at the end of a fjord.



Day nine, the group left the beautiful country of Norway heading to Rovaniemi, Finland.

Rovaniemi is in the arctic circle, one of the Northernmost cities in the world. During the summer, the sun does not set below the horizon, called the Midnight Sun. From September until March, it is possible to witness the incredible Northern Lights.

The group set out late in the evening on an adventure to see the Northern Lights. As the delegation rode into the night on an unpaved road through the forests of Lapland the guide shared about the connection of the Northern Lights and energy. A solar wind can bring highly charged particles to the earth's magnetic field. Unfortunately, this evening the sky was full of clouds, and we enjoyed hot chocolate and each other's company instead of stunning natural phenomenon caused by high-energy particles from the sun.

Day ten, the tour in Rovaniemi started with a visit to Santa Claus village for a meeting with Santa at the Santa Claus office. Rovaniemi is the capital of Finnish Lapland area and is best known as the home of Santa Claus. Santa Claus asked our delegation why we were visiting Lapland and shared his admiration for those who are trying to protect our earth and our natural resources.

We left Santa to visit a Reindeer farm in the forest. We met and learned about reindeer and their importance to Finnish Lapland. There are approximately 200,000 reindeer in Lapland. They all roam free, but each reindeer has an owner. The reindeer are tagged with cuts on their ears. Twice a year the owners all come together and round them up and check on their animals.

In the afternoon, we visited a Husky Farm where these majestic dogs live and train. We had the opportunity to play with some husky puppies and learn about their daily life and key features.



The busy day ended with a lovely dinner in Rovaniemi that of course consisted of reindeer, with many deciding on alternative entrees given the events of the day.



Day eleven, we left the beautiful Lapland area for the capital of Finland, Helsinki. Helsinki was full of light, colors, flowers, and markets. Several took a ferry to the Suomenlinna Fortress. The fortress was built on several Islands just off the coast of Helsinki in the 1700s to protect the country, with many changes in control over the years it now serves as a UNESCO World Heritage site.



On our last day of the mission, the delegation had our final business meeting hosted by Confederation of Finnish Industries (EK), in cooperation with Technology Industries of Finland with overview of Finnish energy system and approach to energy transition, and Finnish Energy colleagues to cover education topics. Confederation of Finnish Industries (EK) is the leading business organization in Finland. Their main task is to make Finland an internationally attractive and competitive business environment, as successful business activities are the foundation for the Finnish welfare society.

Technology Industries of Finland is the lobbying organization for technology industry companies. They promote competitiveness and the operational preconditions for technology industry, the largest and most important export sector in Finland. They state that “a constantly developing technology industry creates the basis for the Finnish welfare state.” Technology Industries of Finland has about 1,800 organizational members.

Mr. Janne Peljo, Chief Policy Adviser, Climate and Biodiversity at the Confederation of Finnish Industries, shared an overview of the Finnish energy system and their approach to the energy transition. Finland has a target to be carbon neutral by 2035. They have a new government, in place since Spring, with new targets they are currently working towards. The government adopted resolution for hydrogen, so Finland can produce 10% of the EU's green hydrogen. There are also over 150 billion in green investment projects in the pipeline in Finland.

The country does not have vast natural resources, so they must work to use and preserve what they have. Finland is made of of 75% forest land, and they have the best mineral reserves in Europe, which can be used for batteries. In 2030, they will be adding more onshore wind to their energy mix. Finland's onshore wind power is the second cheapest in Europe, while Solar PV is third cheapest, 330 GW- 20% of current production. Right now, 98% of Finland's wind power is onshore as it is more cost effective than offshore.

Mr. Peljo spoke about their unique climate roadmap where individual business sector roadmaps are integrated. Finland is number three in the world since 1990 in achieved emission reductions. He did speak of the aging workforce and the need for industry-specific energy skills and competencies.



Mr. Patrick Fostel with Technology Industry spoke on the voluntary Energy Efficiency Agreement Scheme in Finland, it is the first comprehensive plan that aligns with the EU (European Union) Energy Directive. A plan that was initiated as early as 1997. There have been 656 companies who have signed agreements vcovering 6,964 sites, in 121 municipalities. The companies self-attest to energy targets and those have been well reached, with 10.3 TWh saved to date. If a company achieves their savings, they can apply for invest grants from Business Finland.

Mr. Fostel echoed the sentiments of Mr. Paljo that Finland a strong heritage in engineering and energy efficiency/management. However, they have found that 80% of company members have problems hiring new people confirming their need for workforce development in this critical area.

AEE and the Confederation of Finnish Industries (EK) as well as Technology Industries of Finland concluded with meeting with shared interest in cooperating at the upcoming COP28 in Dubai.

Following the meeting, the group had the opportunity to tour Helsinki and learn more about the culture and history, including their great love for saunas and the simplicity of lifestyle. That evening, AEE hosted one final farewell dinner and toasted to new experiences, friendships and connectios made while exploring the Nordics. After sharing trip highlights that included the Northern Lights, the Blue Lagoon and endless waterfalls, the group shared top locations for the next bi-annual AEE Trade Mission.



In conclusion, **Kent L. Hornsby**, P.E., C.E.M, LEED AP (BD+C) is a power system engineer with experience in 50 countries, who attended the AEE Trade Mission. He stated, *“engaging with the global energy sector assumes paramount significance in the pursuit of carbon neutrality. We are uniquely positioned to address the intricacies of power generation, transmission, and consumption on a unified platform, equipped with the requisite tools and resources to optimize this framework effectively. We have been given the resources essential for nurturing sustainability, to integrate into our energy model. Although nations possess diverse*



renewable assets for power generation, it is imperative that we exercise judicious utilization. The Association of Energy Engineers (AEE) emerges as a valuable resource, offering the knowledge and guidance necessary to identify and harness these assets within the framework of our global infrastructure."

AEE Executive Director, Bill Kent shared his overall impression of the mission, "the Trade Mission confirmed once again, that although we may have many differences in location, culture, etc., we are all facing the same global energy challenges. The Nordic region is leading in clean and renewable energy due to their geothermal and hydro resources but must implement energy efficiency measures as they plan for a net zero and clean energy future. AEE's values include People First and Global Family. Everyone we met was welcoming and collaborative and confirmed that working together, we can achieve our climate goals and ensure sustainability for future generations. Thanks for the AEE staff, Trade Mission attendees and the many new friends we made in Iceland, Norway and Finland for making this tour a tremendous success! It was one of the best trips ever for me!



We invite you to follow along, get engaged, and join us as we strive to

"Lead the global energy community to meet the challenges of a clean and sustainable future."

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