REYKJAVIK | EDINBURGH | ABERDEEN

39th overseas excursion of Lämpövoimakerho 2022


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LÄMPÖVOIMAKERHO OVERSEAS EXCURSION 2022

OVERSEAS EXCURSION

Destinations:
Reykjavik 16.-23.8.
Edinburgh 23.-28.8.
Aberdeen 28.8.-1.9.

Excursions in Iceland:
Icewind
Embassy of Finland
Hellisheidi Geothermal Plant
Ljósafoss Hydropower Plant

Excursions in Scotland:
Torness Nuclear Power Plant
Mocean Energy
ORE Catapult
Balmoral
Mackie's of Scotland

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Master of Excursions:
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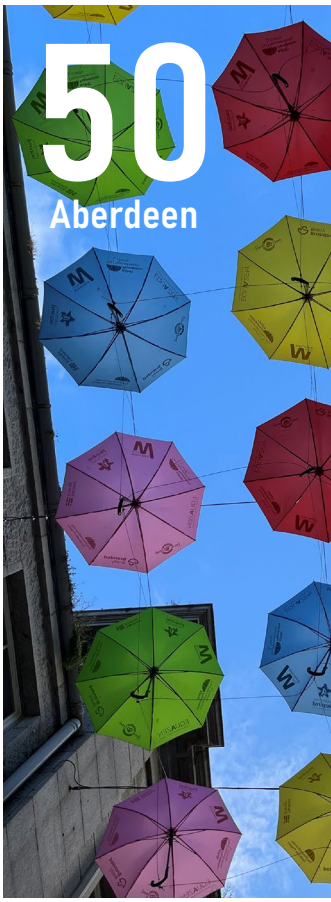

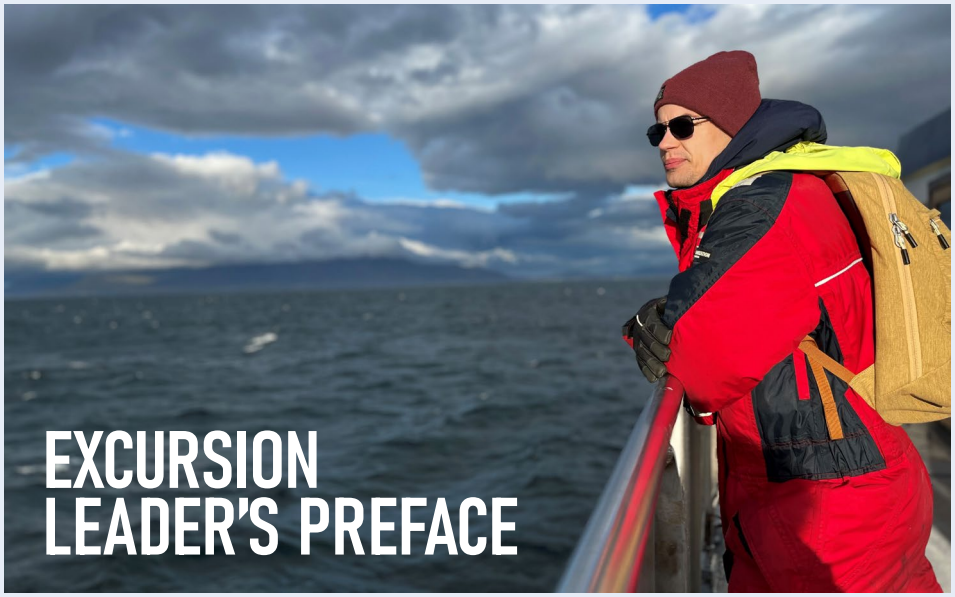

EXCURSION LEADER'S PREFACE

The 2020s have begun with events that have shaken the foundations of the globalized world. Luckily, however, Lämpövoimakerho has managed to hold on to its traditions and organise the 39th overseas excursion.

The planning of the trip started in the middle of the covid pandemic in the fall of 2021 when I and three other organizers decided to see if everything would work out in the end. We set the destinations to Iceland and UK, the islands nations known for their nearly 100 % renewable energy system and massive investments in offshore wind, respectively. UK was later narrowed down to Scotland by majority's decision due to better covid situation and recent news of the 25 GW offshore wind auction.

Later on, the Russian invasion got us on our toes. Like we have all seen, it has had a huge impact on the energy sector, i.e., the companies we were planning to visit and those who were to sponsor us. Luckily, the Finnish energy sector kept an open-mind and continued to see the value in study trips such as this and the students in general.

I would also say that this time it was particularly important to have one of our professors, Annukka Santasalo-Aarnio, with us on the trip, which was not the case on few previous overseas excursions. She delighted us with her expertise, sprouted a lot of conversations and when we were struggling with the changing global situation in the spring, she reminded us of the importance of having something to look forward to. Indeed, it is important to have dreams, dots of light in the dark to focus on.

I guess for us those dots were natural wonders, renewables and carbon free energy production. We saw pretty much the full scale of the current technologies. We visited hydro-, geothermal and nuclear power plants, manufacturers of vertical-axis wind turbines and wave energy converters, offshore and onshore wind turbines and solar PV installation. During the spring before the trip, the excursion group also had the privilege to familiarize us with solar collectors in Savosolar's factory in Mikkeli.

Even the natural wonders we saw had a close connection to the energy field. The eruptions of volcanoes or geysers are essentially massive bursts of thermal energy whereas the water for the famous Icelandic waterfalls comes from glaciers that are now melting away as a result of the global warming. For us, it was truly an inspiration to see these wonders and the technologies that have been developed to help in preserving them for future generations.

Like in every trip, we also had our fair share of obstacles from our hotel going bankrupt month before the trip to having our excursion host double-booked and getting sick during the travel. Fortunately, our group worked well together and there were those who took initiative and took care of the sick, for example. We managed to avoid conflicts between one another and disregard the challenges we faced as minor setbacks.

Now I wish to thank everyone who participated in enabling our unforgettable trip. It would not have been possible without the generous support from our sponsors and the welcoming hosts in our destinations. I hope you, and everyone else reading this magazine, will enjoy – and perhaps even learn something from our stories.

Eetu Laitila

PROFESSOR'S GREETINGS

Learning is a complex process – it is challenging to deeply understand concepts with just few senses. For the past few years, we have needed to limit our learning into reading, writing, looking at videos and preparing assignments. Surely in this way some learning outcomes can be completed, particularly the ones that can be measured, however, the deep knowledge is gained by experiencing and exploring. That is something that is difficult to quantify, but is essential part of learning:

What does heavy wind mean? What does the geothermal energy smell like? How much energy is there in falling water? Can sin-wave be created in a wave tank? How does my height compare to an offshore wind tower?

The highlight of these trips is when you can wonder, explore, question, share and discuss the wider content of this all. These were things that we were able to do every day. The trip created a huge amount of additional information, but even better, a lot of context, for this information. It will take some time to get a better feeling on what was all that we were able to learn along the way.

I would like to sincerely thank the companies that supported this trip and enabled this opportunity for the young talents to come. I would also like to acknowledge the hard work that the students did to make this trip happen and thank them for inviting me to be part of this experience.

I learned so much.

Annukka Santasalo-Aarnio

Meillä tehdään tulevaisuuden energiaa jo tänään!

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ENERGIAA.
TEHOKKAAMMIN.
PUHTAAMMIN.

TRAVEL CALENDAR

ICELAND | SCOTLAND


23.8.
Arriving in Edinburgh


24.8.
EDF
Welcome to
Torness Power Station
Torness nuclear power station


25.8.
Mocean Energy | Arthur's Seat


26.8.
ORE Catapult | Holyrood distillery


27.8.
Football | Edinburgh Castle


28.8.
Travel to Aberdeen


29.8.
Balmoral
Ghost tour
University of Aberdeen


30.8.
Mackie´s of Scotland


31.8.
Dunnottar Castle


1.9.
Travel back to Finland

OVERVIEW OF THE ENERGY SYSTEMS

Sustainable energy production from renewable energy sources is becoming increasingly important as countries set their nationally determined contributions for reaching climate targets. Renewable energy is dominant in both Iceland's and Scotland's energy generation making the countries ideal for an excursion trip.

Iceland is a leader in renewable energy. In 2020 an impressive 90 % of the total primary energy consumption was derived from renewables. Due to Iceland's unique geography and geology the country has a remarkable amount of geothermal energy which accounted for 70 % of the primary energy consumption. Another important renewable energy source in the country is hydropower accounting for 19 % whereas oil consumption accounted for 10 % of the primary energy consumption mainly due to transportation. [1].

Due to the small population of Iceland, the total electricity production is relatively small compared to other countries. However, if you divide the electricity consumption per capita, it is the highest in Europe and over three times higher than in Finland [2]. In 2021 the total electricity production was 19 614 GWh [3] but the per capita consumption was roughly 56 MWh whereas in Finland the number was roughly 16 MWh [2]. The high per capita consumption can at least partly be explained by the energy intensive aluminium production and the fact that over two million tourists visit Iceland during a normal year. However, there is also probably a lot to be done regarding the energy efficiency since currently the incentive to save energy is missing due to low cost of energy.

At least the electricity production is mainly renewable. The total renewable power capacity in Iceland was 2879 MW of which hydropower accounted for 2114 MW, wind energy 2 MW, solar photovoltaics 7 MW and geothermal energy 756 MW in 2021. Renewable energy share of

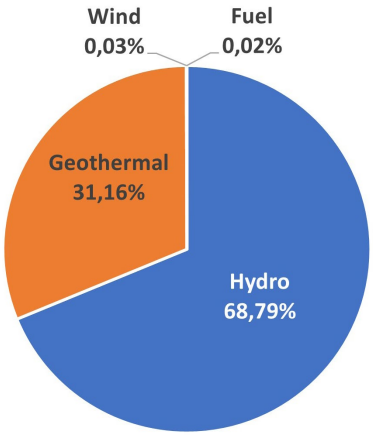

Figure 1. Electricity production by source in Iceland in 2020. [5]

electricity capacity was 97.3 % in 2021. [4].

To reach their carbon neutrality target by 2040 Iceland's focus needs to be on the transport sector which accounts for approximately one third of Iceland's effort sharing emissions. Transforming the transportation sector to carbon neutrality would make Iceland energy-independent. [5]. One option for transforming the transport sector is to build wind power as more electricity is needed

> "To reach their carbon neutrality target by 2040 Iceland's focus needs to be on the transport sector

if energy intensive aluminium production is not shut down. This sector also poses challenges to the green transition as the cheap electricity in Iceland incentivises foreign companies to produce aluminium which is a major source of emissions in the country.

Scotland has set their target to reach net zero emissions of all greenhouse gases five years later than Iceland, by 2045 [6]. Energy consumption in the country was 155 000 GWh in 2020. Considering that only 21 % of this (32 550 GWh) was electricity, the comparison to Iceland is surprising. The population of Scotland is roughly the same as in Finland (almost 20 times higher than in Iceland), but the electricity consumption is only roughly 1.5-fold. Most of the enerfgy consumed in Scotland is in the form of heat which accounted for 51.5 % of the consumption in 2020. The remaining 24.5 % is consumed by the transport sector. In the heating sector, renewables (mainly biomass and heat pumps) account for roughly 6 % of the production whereas gas is the major source of heat. [7].

Scotland has over 13 GW of renewable electricity generation capacity and in 2020 renewable energy production was equal to 97 % of Scotland's gross electricity consumption. Onshore wind is the biggest single technology with 66 % of installed renewable capacity and offshore wind, hydro and solar photovoltaics are other major sources of renewable power. [7]. Figure 1 shows how electricity production is distributed between different sources in Scotland.

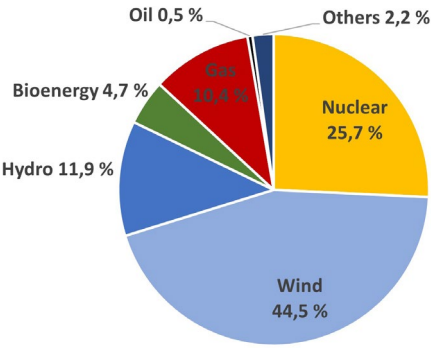

Figure 2. Electricity production by source in Scotland in 2020. [8]

Scotland is also a major exporter of energy and in 2020 their net-exports accounted for almost 40 % of the production. While most of the production comes from renewables, gas production still accounts for 10 % of the production. [8]. One should also note that although nuclear power currently accounts for a large share of the electricity production, Torness power station supplying an impressive 1190 MW is being shut down by 2028 ending the nuclear production in Scotland [9]. Instead, the green transition in Scotland is being sped up by offshore wind. Just recently 8,600 km2 of sea bed was auctioned to host up to 25 GW of offshore wind with most of the capacity being floating offshore wind [10].

Wind power is the dominant source of electricity in Scotland, whereas in Iceland hydropower has the highest share of installed capacity and wind power plays a negligible role in the energy mix. While Iceland has always had a closed electricity market it is interesting that a subsea cable connection to Western European electricity markets is discussed every now and then. The cable would be at least 1000 km in length making it the longest subsea cable in the world [11]. It would connect Iceland to Scotland and go all the way to the European continent [11]. The losses in the cable would be significant which is why the project hasn't been carried out but for us it was an interesting anecdote as the cable would connect both our destinations.

Heidi Manninen

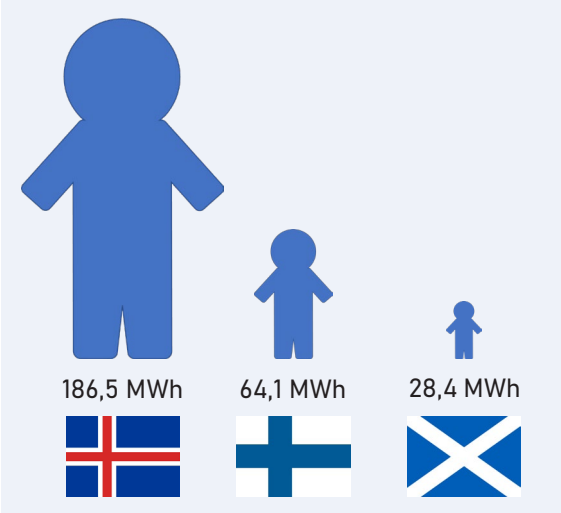

Figure 3. Primary energy consumption per capita for Iceland, Finland and Scotland in 2020. [1, 12, 7]

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Etsimme tänäkin vuonna mukavaan työporukkaan energia-alan IT-ratkaisujen pariin kesäharjoittelijoita. Ratkaisuillamme mahdollistamme energia-alan yritysten siirtymisen ympäristöystävällisempään energian tuotantoon. Hansen Technologies on markkinajohtaja Suomessa ja vahvassa kasvussa Euroopassa. Suomessa Hansen Technologies työllistää noin 120 työntekijää.

Kesäharjoittelussa meillä voit valita haluatko keskittyä mieluummin ohjelmistokehitykseen vai ohjelmistotestaukseen. Räätälöimme harjoittelun tehtäväkokonaisuudet kokemuksesi, osaamisesi ja mielenkiintosi mukaan. Kesäharjoitteluun voi hakea riippumatta siitä, oletko opintojen keski- tai loppuvaiheessa, tai vaikka vastavalmistunut.

Kun tulet meille kesäharjoitteluun

- Pääset heti Scrum-tiimin työskentelyyn mukaan osaksi tiimiä
- Saat osaavat ja mukavat kollega, joiden kanssa työskennellessä opit paljon
- Osallistut oikeisiin asiakasprojekteihin työkavereiden tukemana
- Saat henkilökohtaisen tutorin tueksesi ja perehdytyksen työtapoihimme
- Sinulla on mahdollisuus syventyä energia-alaan ja sen käyttämiin ohjelmistoihin

Odotamme kesäharjoittelijoilta:

- Hyviä vuorovaikutustaitoja, koska työ tehdään tiimissä
- Sujuvaa englantia työkielenä, koska työyhteisömme on kansainvälinen
- Halua oppia ja kehittää omaa tekemistä
- Rohkeutta kysyä apua ja tukea tarvittaessa

Jos sinulla on jotakin alla olevista osaamisista, ne edesauttavat tiimiin solahtamista (mutta kaikkia näitä emme oleta kesäharjoittelijalla olevan):

- Olio-ohjelmoinnin ymmärrys (pääohjelmointikielenämme on C++ ja lisäksi käytämme mm. C#:ia)
- Ohjelmistotestaamisen ja testiautomaation perusteet (käytämme Robot Frameworkia ja Pythonia)
- Ymmärrys ohjelmistokehityksen eri vaiheista
- Tietokantojen perusteet (SQL)

Jos viihdyt meillä kesäharjoittelussa, pyrimme järjestämään mahdollisuuden jatkaa kesän jälkeen osa-aikaisena tai kokoaikaisena tilanteestasi riippuen. Kesäharjoittelu on kokoaikaista, mutta myös osittaisesti osa-aikaisuudesta voidaan sopia.

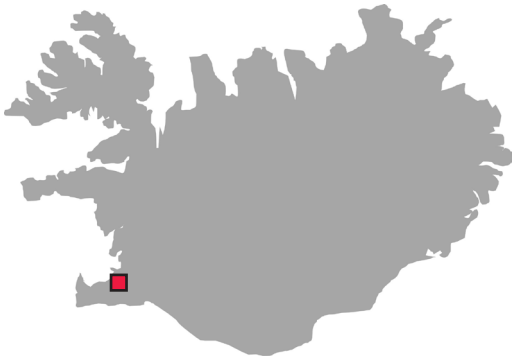
Aloitin vuonna 2019 ja tein silloin pääsääntöisesti testaushommia. Pääsin tutustumaan erilaisiin testauksen työkaluihin ja käyttämään niitä. Työkaverit olivat supermukavia ja auttavaisia, minkä ansiosta pääsin hyvin nopeasti mukaan tuottavaan työskentelyyn. Olen oppinut yhden kesän aikana enemmän kuin koskaan ennen. Taitoni kehittyivät hirveän nopeasti mm. ymmärrys energia-alasta ja ohjelmistokehityksestä. Työilmapiiri oli mahtava ja työtehtävät olivat monipuolisia. Hansen tarjosi myös hyviä etuja kesätyöntekijöille. :) (Nga, kesäharjoittelija 2019)

Haluaisitko kysyä kesäharjoitteluun liittyen jotakin? Lisätietoja antavat ja kysymyksiin vastaavat sähköpostilla rekrytoiva esihenkilö Kari Saari, Senior Software Development Manager (kari.saari (at) hansencx.com) ja Kasper Kuusela, Talent Acquisition Partner EMEA (kasper.kuusela (at) hansencx.com).

Kesätyöntekijähakumme aukeaa virallisesti tammikuun lopulla ja pääset katsomaan avoimia roolejamme nettisivuiltamme www.hansencx.com/careers . Haun auettua, kerrothan hakemuksessasi, millaisista tehtävistä toivoisit kesäharjoittelun koostuvan.

REYKJAVIK

THE CITY OF FIRE AND ICE



Reykjavik, also known as the "bay of smokes" in old Norse, is the capital and the largest city in Iceland. Residing in the south-western Iceland hugging the North Atlantic Ocean, this beautiful but cold coastal city offered us a surprisingly warm welcome for our excursion.

The Icelandic people, aka Icelanders, really own the "Nordic mindset". Despite being humble, kind, reliable and laid back, they still are earnest and capable. Iceland is an isolated country of harsh conditions, and this requires its residents to be hard-working problem solvers. Icelanders are also very interested in societal matters and like to express their opinions with confidence. During our stay in Reykjavik, we noticed one Icelandic personality trait that shone brighter above anything else and set the mood for the entirety of our excursion. It was the positive mindset that said, "everything will work out all right". This mentality was so prevalent that Icelanders had their own saying for it. Þetta reddast! Quite quickly, this also became our motto for the rest of the trip.

We had two rental cars for the whole duration of our stay in Iceland. Even though Reykjavik's inner public transport works pretty well, there are no public railways in Iceland. That's why the cars were such a practical choice, especially on the longer day trips. They gave us a lot of freedom and a possibility to be more flexible with our schedules. Travelling by driving our own cars also made the time on the road feel way more fun and authentic.

Driving into Reykjavik feels like driving home to safety from the beautiful but almost alien-like scenery and unfamiliar landscape. The appearance of the Icelandic nature is really volcanic and exotic compared to our homeland. High hills and mountains of black rock, green moss covering the land, and the absence of trees really make you feel far from home. The city of Reykjavik, however, feels oddly familiar with its low and boxy architecture focused on functionality. This doesn't make the city look boring though. Like many of the other Nordic countries, the influence of Scandinavian design can be seen walking through the city making it feel friendly and welcoming. You can even find the Nordic cultural centre "Pohjolan talo", which was designed by Alvar Aalto, in the Reykjavik city centre. Still, there are things that break the familiar Nordic feeling every now and then, like many famous American restaurant and department store chains. These include fan favourites like Domino's pizza and Costco. Despite this, Iceland is one of the only countries in the world where you can't find a McDonald's.

Speaking of food, Reykjavik has a lot to offer. Despite being a city in a secluded island country, you can find restaurants of almost any culture from around the world. Iceland's own food culture has been moulded by the country's location and the available produce and ingredients. The most prominent and traditional Icelandic foods are, of course, lamb and fish. Eating these in proper restaurants can be a bit expensive though, so we opted for the more affordable choices of culinary tradition – fish and chips, and the gas station lamb meat hot dogs. Also, it is not only the food

that is a bit more on the pricier side. One should be prepared for the relatively high price level in just about everything.

The weather was just about what you would expect from a coastal city on an island - windy, cool, and rainy. We were told that this year was the wettest in 100 years. Considering this, we were pretty lucky with the weather on our day trips outdoors. On these days, there was little to no rain and we even got to see the sun popping out now and then. We also learned that the cold weather has an interesting effect on the Icelandic climate. The gas station clerk, who sold us our hot dogs, told us that thunder is seldom seen in Iceland. The first time he had ever seen lightning was when he was visiting Finland. The reason for this is the temperature of the ground staying constantly cool during the year not allowing a lot of thunder clouds to form.

Not everything in Iceland is cold like the weather though. The temperature of the hot water coming from faucets and showers is not capped like in Finland so it can be scalding hot. Around 90 % of the warm water is heated by geothermal sources and the temperature of the water can be up to 80 degrees Celsius. Still, the warmest thing in my opinion was the welcoming atmosphere surrounding us everywhere we went. The Icelandic people think favourably of Finland, and it is noticeable. Moomin mugs, Aalto vases, and Finnish candy can be regularly seen in the stores or as decorative items. Still, I bet us being Finnish isn't the reason for our warm welcome. The true reason is the city and the people in it. Afterall, the official motto of Reykjavik is: "Reykjavik loves".

Tuomas Orava

RENEWABLE POWER FOR REMOTE LOCATIONS

ICEWIND

Iceland is a country of harsh weather and fast changing conditions. Another unique aspect is that the country is on the boundary of two tectonic plates, Eurasian and North American plates, which are drifting apart. This results in an ideal opportunity for geothermal energy to be used. Because this resource is so easy, cheap and renewable, the country relies heavily on it. Another vastly used energy source is hydropower. These two sources alone provide 85 % of the country's primary energy demand and over 99 % of its electricity demand.

Many countries can currently only dream about having such a major share of the energy produced from renewable sources but there is still something to improve in order to reduce emissions. So how can a country with this much renewable energy do better? Thermal and hydro power are both renewable and reliable sources of electricity but there is still a need for fossil fuels in, for example, some weather stations and telecom towers which are often quite far from any infrastructure and require diesel generators. Because the country is so sparsely populated, it is not beneficial to extend the power grid to every part of it. Weather stations and telecom towers require stable and reliable sources of electricity but because the country's most used sources are not feasible options for these distant locations, there is a demand for another renewable energy source. This is where Icewind has found a solution.

> "Innovations and solutions towards a cleaner future don't always have to be huge changes

In a land of strong winds there is a lot of energy to be harvested from it but the biggest problem is the extreme wind conditions. Traditional wind turbines couldn't withstand such strong gusts and fast-changing conditions. Therefore a completely different kind of turbine had to be developed. Icewind is a company that develops wind turbines that can endure the extreme Icelandic weather and provide a stable power source in a variety of conditions. Their turbines are vertical axis wind turbines that can withstand up to 70 m/s gusts of wind

Icewind's turbines were used to power the measurement equipment by the volcano Fagradalsfjall in the 2021 eruption

with the possible production range between 2 and 30 m/s but the goal is to produce energy even at wind speeds of 70 m/s.

These turbines use both inner (savonius) blades and outer (darrieus) blades for converting wind's kinetic energy to mechanical energy, which is further converted into electrical energy in the generator. With these two blade types combined, the turbine uses the best features of both types and produces electricity in a broad range of wind speeds. The power generated at 10 m/s is around 150–600 W, which is more than enough for weather stations and telecom towers. Although there is a lot of wind, the telecom towers and weather stations require a stable source of electricity. For the windless times there needs to be either a battery system or a fossil fuel, usually diesel, powered generator.

With an increasing population, there is also an increasing need for electricity globally. Combined with the digitalization and the accelerating progress, reliable and renewable means of energy production have to be developed. With 5G becoming more and more popular, the need for masts is ever increasing and they will require electricity wherever they are erected.

Icewind's turbines are robust and require little maintenance over their over 25 year lifespan, which is extremely important in these often very distant locations. They are easy to install and don't require huge amounts of transportation and building as regular turbines do. Being the only turbine developer in Iceland, the products are truly made for their own country's conditions. It is even surprising that such great products have been produced with such a little help and industrial facilities. Icewind's wind tunnel testing is driving on a straight road with the turbine attached to a trailer. In my opinion this shows how much can be made simply with a lot of ambition and will.

It will be seen if these kinds of systems will become more popular in Iceland and in other remote regions. It might be hard to change the old ways especially in regions where it is difficult to maintain a stable energy production. Also when there has been nearly no wind power, the legislation and permitting are not updated for larger usage. Icewind's goal to provide renewable energy even to the most distant and harshest regions is a good reminder that innovations and solutions towards a cleaner future don't always have to be huge changes. Even small actions in increasing the share of renewables are important and needed.

Joonatan Mustonen

ICELAND FROM A FINNISH POINT OF VIEW

EMBASSY OF FINLAND IN REYKJAVIK

It was an honour to get to visit the Embassy of Finland in Reykjavik. The main targets of our visit were to hear how Iceland comes across from a Finnish point of view, to learn about Iceland and to hear about the cooperation between the countries. We learned a lot about Iceland and understood some key points of Icelandic society. We were pleased to visit the embassy already on the second day of our excursion, so we got a frame of reference for all the excursions and adventures during the following days in Iceland.

Finland's ambassador to Iceland was unfortunately not available during our visit. Along the circulation system, the ambassadors change regularly and our visit was just when the change was happening. Former ambassador Ann-Sofie Stude was finishing her term and the new Head of Mission, Anu Laamanen, was starting right after our trip. However, the welcome was warm as we were hosted by Adviser Anna-Katri Koskivirta and Trainee Sofie Lagerroos. Property Management and Office Services Attendant Sverrir Kristfinnsson greeted us and answered some of our questions. The elegant 100-year-old embassy building welcomed us too with large, light rooms and a distinguished atmosphere.

Adviser Koskivirta had prepared us a presentation about Iceland, and we got a wide overview of the country. We got to know the basic information of the population, domestic- and foreign policy, economy, living in Iceland and collaboration between Iceland and Finland. It was interesting to hear that many Icelanders have suspicions of business people and the government because of the financial crisis in 2008, despite the well-being thereafter. For example, we detected some scepticism towards the aluminium industry that has formed in Iceland due to cheap energy. The industry covers around 30 % of Iceland's GDP but its benefits to Icelanders and contribution to the welfare state was questioned. The other two main industries are fishing and tourism with similar 30 % shares of GDP.

Regarding energy, Iceland is a unique place. There is an abundance of renewable and adjustable energy resources: geothermal energy and hydropower. Electricity is mostly produced with hydropower and secondly with geothermal power, whereas space heating is fulfilled mostly by geothermal energy, most commonly using district heating systems. Contrary to other European countries, Iceland's power grid is an island, meaning that there are no connections to other countries. That makes the price of the power low also during the energy crisis in Europe. The cheap energy drives people to consume more energy: when some of our group said it is too warm in the embassy, the concept of "Icelandic air conditioning" was introduced to us – open the window and turn the heating up.

We had an interesting conversation about the future of Icelandic power production. Now, transport is the sector that consumes most of the fossil fuels imported to Iceland, basically oil products. It is obvious that in the country of cheap and abundant renewable power, whose goal is to achieve carbon neutrality by 2040, the transport will be electrified. Because of the increasing demand for power there are plans to build more wind power. As a windy island, there is a huge potential for both onshore and offshore wind power in Iceland. Though the heavy storms restrict the wind turbines to the ones that survive in these extreme conditions.

We couldn't help but wonder the suitability of wind power in Iceland. Icelanders have a lot of adjustable hydropower to get along with a certain amount of weather-dependent wind power. But what are the environmental impacts of large-scale wind power? Would the delicate Icelandic

nature suffer? In Iceland there is but a little vegetation to hinder the visibility and noise, so what would be the effect on tourism when the turbines appear in the picture perfect scenery? We were also wondering if the feasible resources of hydro- and geothermal power are all already used since the Icelandic people have become increasingly interested in the fluctuating wind power. Perhaps offshore wind could be the solution. We got to see offshore wind in action later in Scotland and found out how unnoticeable that is in the skyline.

Time will tell what Iceland decides to do, but that conversation gave us an important lesson: It is very important that the decisions are made with the best available information and calculations. If the experts are not heard, good-looking decisions like "Let's build more wind power, it's sustainable!" or "Let's close the nuclear power plants, they are dangerous!" can be made without thinking about the big picture.

> "Outdoor life cannot be planned weeks before, when there's a risk of a storm with hurricane-speed winds

Lastly, Koskivirta and Lagerroos described the cultural differences between Iceland and Finland. There was a particular thing they had noticed: Icelanders tend to plan their schedules for a shorter period than Finns. In addition, things are often done at the last minute. Maybe the rapid-changing and extreme weather is one of the reasons for that: outdoor life cannot be planned weeks before, when there's a risk of a storm with hurricane-speed winds. "Þetta reddast!" say the Icelanders: it's all going to work out in the end.

Jaakko Kivekäs

Insinööriosaamisella kestävämpään tulevaisuuteen

Teknologia- ja insinööriosaamisen tarve ei ole vähenemässä, päinvastoin. Kestävän kehityksen haasteet, energiatehokkuuden lisääminen, päästöjen vähentäminen, raaka-aineiden säästäminen kaikki tarvitsevat insinööriosaamista.

Glasgow'n ilmastokokouksessa syksyllä 2021 julkistetun selvityksen mukaan teknologia-alan asiantuntijapalveluiden ilmastokädenjälki on merkittävästi suurempi kuin alan oma hiilijalanjälki. Tämä on totta myös teknologiapalveluyhtiö Etteplanin toiminnassa: suurin mahdollisuutemme vaikuttaa ympäristöömme on asiakkaidemme liiketoiminnan kehittämisen kautta ja omat suorat vaikutuksemme ovat vähäisemmät.

Olemme selvittäneet toimintamme kokonaisvaikutuksia Uprightin nettovaikutusmallin avulla, jos-sa arvioidaan yritystä ympäristön, terveyden, yhteiskunnan ja tiedon osa-alueilla. Sen perusteella Etteplanin nettovaikutus on erittäin positiivinen.

Merkittävin vaikutuksemme on yhteiskunnallista: luomme työpaikkoja ja maksamme veroja toi-mintamaissamme. Asiakastyömme kautta osallistumme myös yhteiskunnan kannalta kriittisten toimintojen kehittämiseen esimerkiksi kuljetus- ja energiasektoreilla.

Vaikutuksemme näkyy myös tiedon lisäämisessä, jota korkeasti koulutetut ammattilaisemme kaikilla liiketoiminta-alueillamme tuottavat.

Ilmastovaikutuksemme syntyvät arvoketjujemme ja asiakkuuksiemme kautta. Omat päästömme ja ilmastovaikutuksemme ovat pienet, mutta nettovaikutusmallin mukaisesti otamme kantaak-semme myös asiakkaidemme ilmastoriskejä ja -vaikutuksia. Tässä asiakkaidemme toimialoilla on iso merkitys, ja merkittävä osa asiakkaistamme toimii esimerkiksi energian, liikenteen ja kulje-tuksen tai raskaan teollisuuden aloilla. Näillä aloilla teemme tärkeää työtä auttamalla asiakkai-tamme vähentämään päästöjä muun muassa tehostamalla ja optimoimalla toimintaansa sekä kehittämällä esimerkiksi uusiutuvaan energiaan ja resurssitehokkuuteen liittyviä tuotteita, palvelui-ta ja prosesseja. Omilla ratkaisuillamme ja innovaatioillamme voimme siis vaikuttaa asiak-kaidemme ilmastovaikutuksiin myönteisesti.

Suunnittelualalla tehtävät toimenpiteet ja ratkaisut voivat saada aikaan suuria positiivisia vaiku-tuksia koko arvoketjussa ja yksittäisen alan asiantuntijayrityksen vaikutus ympäristöönsä on merkittävästi kokoaan suurempi.

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GEOTHERMAL ENERGY IN ICELAND

HELLISHEIDI POWER STATION

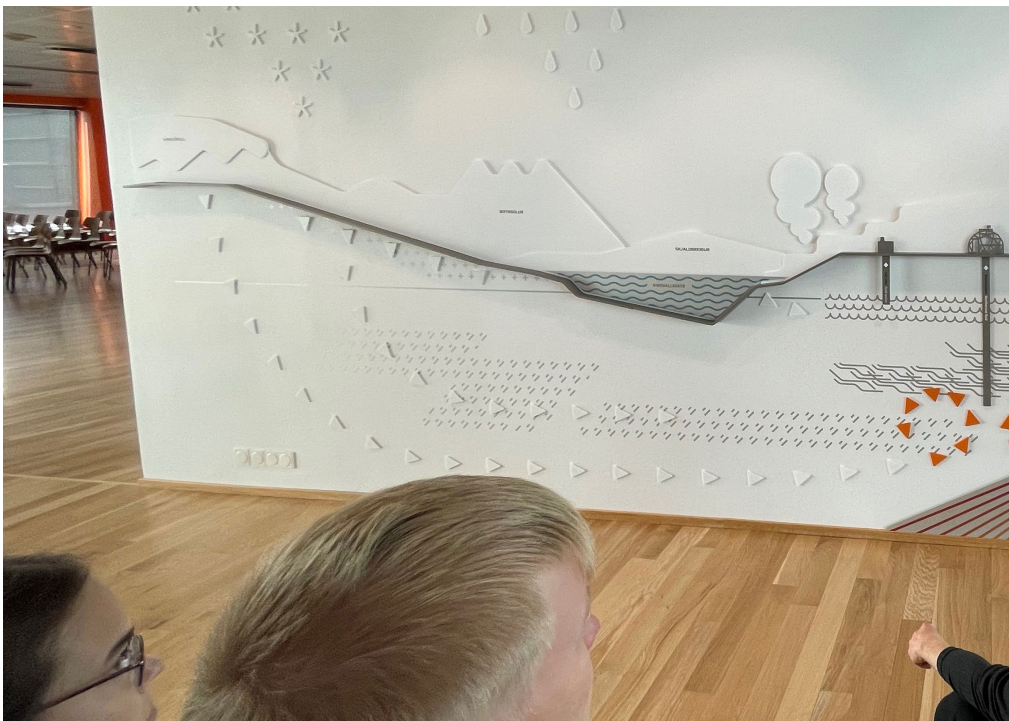
Iceland is located on the boundary of the Eurasian and North American tectonic plates. The plates are diverging from each other, and new oceanic basin is being formed. This gives the area a volcanic nature, causing earthquakes and eruptions. Besides being located on the plate boundary, Iceland also lies on a volcanic hot spot. Within the Earth's mantle, mass and energy are being transferred between the interior parts and the crust by a convection flow. The phenomenon, known as the mantle plume, is responsible for the appearance of hot spots. Basically, massive volumes of magma are being pumped from the Earth's depths up to the crust, and the hot spots are appearances of this phenomenon at the Earth's surface. However, the position of a hotspot is independent of the proximity of a tectonic plate boundary and is affected by other factors. In Iceland, a hotspot and a plate boundary both appear in the same location, making the area extraordinarily volcanic. The co-appearance of the two phenomena is actually the fundamental reason for the existence of Iceland.

The people of Iceland have gained expertise in exploiting this unique thermal resource. In 2020, geothermal energy covered 31 % of the nation's power demand and 90 % of space heating demand, accounting for over two thirds of the primary energy consumption. Geothermal energy thus acts as a major building block of the country's energy system, together with hydroelectricity, providing clean, reliable and affordable energy for the small nation.

During our one-week visit, it was noticeable how cheap and abundant the energy, especially the heat, actually was. In many locations, steam was directly just rising from the ground. The abundance of energy could also be observed from the attitudes of the locals – "an Icelandic air conditioning is having your radiators on and windows open". Also the presence of the aluminium industry, that is well established in Iceland, clearly indicates the stability and availability of low-cost energy. The so-called Hall–Héroult process, in which aluminium oxide is electrolytically reduced into pure aluminium, consumes enormous amounts of electricity and requires a stable and inexpensive power source. In Iceland, the aluminium industry covers one third of the country's economic output, being operated by overseas companies, though.

The abundance of energy felt contradictory, as while writing this post, Europe is being hit by an energy crisis. The key learning from Iceland still is the following – with the competence in using their exceptional energy resources, the Icelandic people have managed to build a highly self-sufficient and low-carbon energy system, that is mostly independent of the global energy markets. Basically, only transportation fuels need to be imported. Furthermore, their energy system is probably the only one among the developed countries that is even close to being environmentally sustainable. All this just underlines the value of the geothermal energy resources.

On September 18, the third day of our stay in Iceland, we visited the Hellisheidi power station, the largest geothermal plant of the country, that also supplies district heating for the city of Reykjavik. The plant is located 20 km east of Reykjavik on the Hengill geothermal area, one of the largest high-temperature geothermal fields in Iceland. The plant is operated by Orka Náttúrunnar, a local energy supplier owned by the city of Reykjavik. The electricity generation is based on a conventional thermal power conversion with steam turbines, combined with a 2-kilometre-deep borehole, from which the steam is directly extracted.



The nature-formed energy reservoir is stunning – from the depth of 2 km, a 20/80 mixture of steam and water is obtained at a temperature of 300 °C and pressures of 30-70 bar. In Finland, for comparison, the bedrock temperature at the depth of 2 kilometres ranges between 20-40 °C. The Hellisheidi power station is equipped with 7 turbines, providing electric output of 303 MW, most of which is being supplied to the nearby aluminium refineries. The plant also covers one fourth of Reykjavik's heat demand with a 400-MW thermal output.

Our host at the Hellisheidi power station also pointed out that geothermal energy is not totally free of greenhouse gas emissions, but small fractions of CO2, H2S and H2 are emitted, covering altogether 0.4 % of the outlet stream. These emissions are still minimal compared to fossil-based power generation. Nevertheless, the power station was also equipped with an emission capturing pilot plant, named Orca, where carbon and sulphur emission sequestration technologies were being demonstrated. The geothermal gases were reinjected back into the basaltic bedrock where they become mineralized and sequestrated as solid rock. Interestingly, as the sulphur and carbon are initially originating from the Icelandic bedrock, a local material circulation loop is formed, where the elements are returned back to their origin, instead of being liberated to the atmosphere.

The Orca plant is part of the CarbFix and SulFix research projects, carried out by Orka náttúrunnar together with three universities and two startup companies. The concept has proven to sequestrate carbon and sulphur emissions – the mineralization process is shown to take place only in few years, while millions of years had been formerly expected by the scientific community. The technology has gained wide interest, not least because of the urgent need for CCS technologies in addressing the climate change, but also because the basaltic bedrock is commonly found in the Earth's crust. The Orca plant was the first CCS demonstration that Lämpövoimakerho had ever visited, and it remains exciting to follow whether the technology will commercialise someday.

To conclude, the excursion to the Hellisheidi power station was enlightening in many ways, encompassing the role of geothermal energy and the importance of the volcanic activity for the country.

Ahti Myllymäki

> **"The Icelandic people have managed to build a highly self-sufficient and low-carbon energy system**

ADJUSTABLE POWER PRODUCTION

LJÓSAFOSS HYDROPOWER PLANT

Our fourth day started with a visit to the Ljósafoss hydropower plant owned by Landsvirjkun, the local Fortum. The plant started its electricity production in 1937, when the plant had two turbines with a combined power of 8.8 MW. In 1944, a third turbine with a power of 6.6 MW was installed. The plant is therefore quite small in terms of power. Iceland has a great amount of hydropower with an overall capacity of 2024 MW. Iceland's average electricity consumption is around 2200 MW over the year and installed electricity production capacity is over 2900 MW. High amount of hydropower makes it rather easy for Iceland to balance their electricity production and consumption because hydropower plants can adjust their output power quickly and so balance the grid frequency.

Iceland is producing all its electricity by itself and it has no transmission cables to other electricity grids mainly because of its geographical location. This forces Iceland to have excess capacity in its own electricity production compared to consumption because electricity cannot be distributed from other areas to Iceland. The isolated location makes Iceland's electricity market really unique. There has been discussion about possible transmission cable between Iceland and the UK but due to long distance between the countries the energy losses of the cable would be remarkable. Also consumers' electricity prices would increase because of the connection to the UK, but electricity producers in Iceland would benefit from the price increase.

On our excursion day, we arrived at the plant at 10:50, 10 minutes before our reserved tour with the plant manager. However, there had been a double booking and the manager had another tour ongoing, so we had to explore the hydropower plant by ourselves. Luckily, the power station had a very nice visitor centre, which explained the history of electricity production and the current situation of the electricity production in Iceland and the world overall.

The visitor centre was targeted for people who have no previous experience in the energy sector. The history part of the visitor centre was really nice and interesting but the facts about the actual plant were too broad and it would have been more exciting to hear specific facts about the plant. We asked if we could go to the turbine hall but the hosts of the visitor centre couldn't let us there. They were really sorry about the double reservation and encouraged

High amount of hydropower makes it rather easy for Iceland to balance their electricity production and consumption

us to give feedback about the visit. They told us that we could have our tour with the plant manager at 13:00 but unfortunately we couldn't wait that long. We asked permission to go on top of the dam and luckily it was allowed. We had a really nice view on the dam and we were able to follow the current bypass of the water. We took some group photos next to the bypass stream and left.

After the excursion our professor Annukka commented that she was involved in a project in Finland where a similar visitor centre was made for Heureka. Her opinion was that Finnish companies should have more of this kind of illustrative visitor centres where, for example, elementary schools could visit. It is much easier to understand the facts related to for example hydropower when you hear the information while you can see the actual plant. The plant also had games related to energy which are a great way to teach students.

We saw two visitor centres in Iceland, one at the geothermal power plant and the other at the hydropower plant. Both were very nice and simplified in a good way. Finnish companies could learn something from Icelandic companies and their visitor centres.

Väinö Tuuli

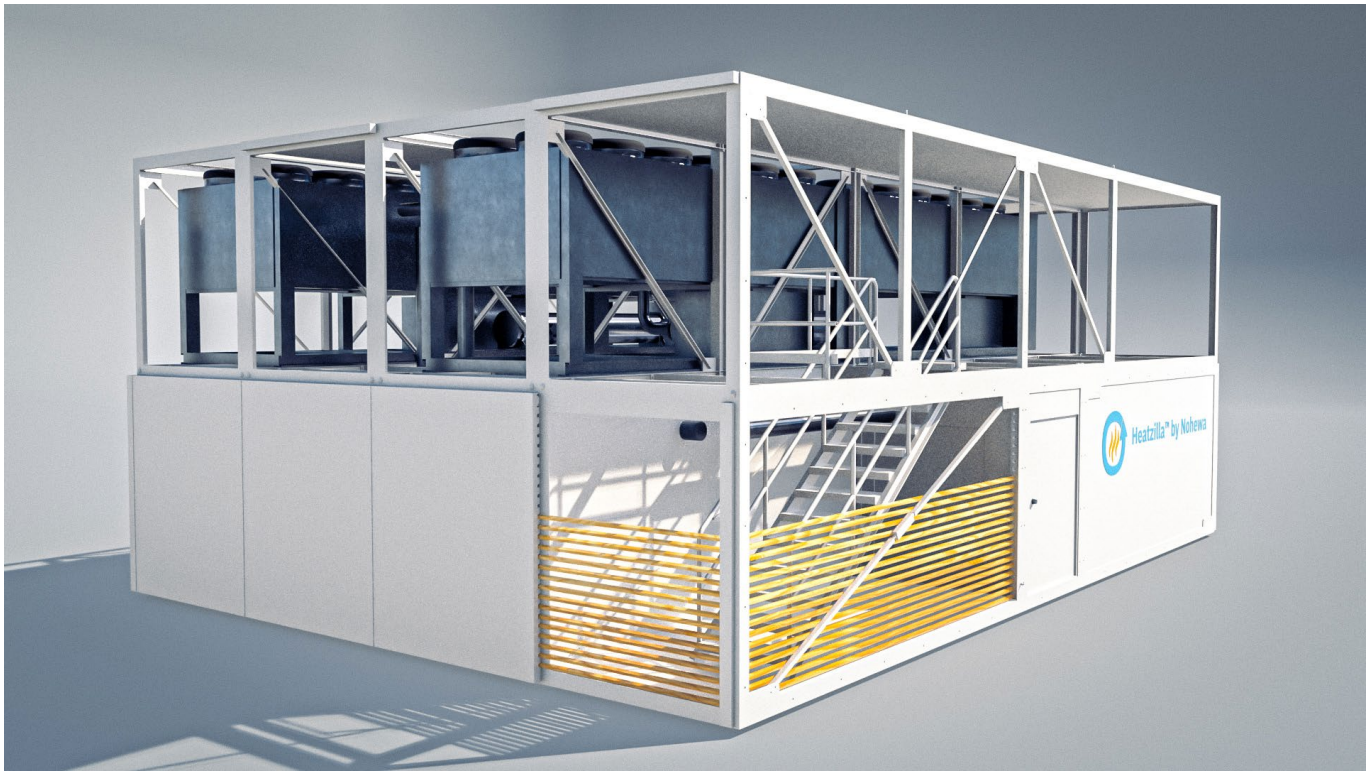
NO SUCH THING AS HEAT "WASTE"

Energy needs in the countries we visited looked vastly different compared to Finland. Iceland, for example, gets approximately two thirds of its primary energy in the form of geothermal heat due to its energy wise lucky position between tectonic plates. Scotland on the other hand does not face as harsh winters as Finland and therefore electricity production is their priority. Having spent a couple of cooler days in Scotland though, I personally really wish that Brits would take heating and HVAC technologies a bit more seriously but hey, these are the cultural differences.

In Finland, we face different conditions. Roughly half of our produced energy is in the form of heat. Especially during winter, we need vast amounts of it simply to keep our houses warm and our society running. We do not have superb natural resources, as Iceland does, while still having a lot of heavy, energy intensive industry. The way Iceland gets energy feels almost unfair, but every country must play with the hand they are dealt. And lucky for us, we have a new ace in hand – waste heat extraction.

Nohewa, a Finnish start-up company, is one the players holding this card. The focus of the company is the waste heat from industrial processes which can be utilized using heat pump systems. Currently, the common way of dealing with excess heat is to release it into air which sounds just as crazy as it is. According to Motiva, up to 6-23 TWh (8-29 % of Finnish district heating) could be replaced by more effective heat collection systems. The waste heat collection does not just utilize excess energy, it effectively reduces the total emissions of the whole system since much of the needed district heat is produced via carbon-heavy solutions in Finland.
From many companies' point of view, waste heat is just that: waste. Why should they use resources for capturing waste that doesn't affect the environment in any way? For any person familiar with the energy sector, the answer is obvious: energy is valuable and heat energy especially is relatively easy to capture and utilize in other processes. Still, the world revolves around money and without profits as an incentive the role of "waste" heat changes slowly. Climate goals are pushing the change and hopefully soon enough the reduced emissions alongside accumulating profits can reduce the amount of waste heat thrown away.

> The way Iceland gets energy feels almost unfair, but every country must play with the hand they are dealt



Nohewa does heat pump systems as a comprehensive solution where they plan, implement, deploy, and possibly even operate the plant. Many companies offer different waste heat recovery systems. Nohewa has found their place in the market by providing very customer-friendly and non-intrusive services which do not disturb the day-to-day life of their customers but still turn previously discarded waste heat into a valuable resource. Everything from the first feasibility assessment to operation and maintenance is taken care of by Nohewa so the client company can focus on their own business. Different sources of heat that Nohewa utilizes in their operations are e.g. waste heat from data center cooling water as well as heat in air, large water bodies, and hydrogen production.

The current societal climate proves that companies benefit greatly from self-sufficient systems that are not as prone to great disturbances of external political disasters. Having a system that reliably produces heat means stability for profits and reduced risks of suffering from price fluctuations of fuels. Concurrently, utilizing waste heat also mitigates the emissions produced from heating in an energy system.

All in all, we in Finland face harsher conditions than in Scotland and we are not as lucky in terms of natural resources as our fellow energy specialists in Iceland. This means that we have to be creative and find possibilities in unconventional places. Nohewa is a shining example of how a start-up company can niche and execute its plans professionally and efficiently - while simultaneously reducing the total emissions in an energy system.

> **Nohewa has found their place in the market by providing very customer-friendly and non-intrusive services which do not disturb the day-to-day life of their customers**

Markus Manninen

**This article is sponsored by Nohewa*

PEACEFUL BATHING AND THE BEST ATTRACTIONS

GOLDEN CIRCLE

To begin with, the Golden Circle tour was a brilliant chance to see it all. Not literally, but many different natural phenomena in Iceland at once. We got up early in the morning and realised later that it was totally worth it. The first sight of the tour was Reykjadalur hot springs, a naturally heated thermal river. The hike there wasn't as challenging as the previous hike at the volcano, but I think most of us (me at least) had to fight for our breaths at some point. There was a hint in some travel advertisement that you should get there as early in the morning as possible – and they were right.

During the hike you got that certain feeling; the same feeling you get walking in the forest in Finland. Everything seems so peaceful, there's no trace of people ever being there. Especially, since we went there early in the morning and didn't see any other hikers on our way to the river. Coming back in the other direction at least 30 people passed us in smaller groups, and it took away the extraordinary and rare feeling of being the only people there in the middle of mountainous nature.

Bathing in the hot river, we felt truly close to nature as it wasn't commercialised like the Blue Lagoon, where you can buy for example face masks and drinks straight from the pool. It was amazing how warm and even hot the water there was - without the humans warming it up. On our way there we saw these bursts of steam coming out of the ground. It was impressive since you don't get to see that in Finland – a glance of geothermal energy. Speaking of which, we witnessed the power of energy below the ground visiting geysers later that day.

Geothermal areas in Iceland are divided into high and low temperature areas depending on the nature of the geothermal system. The high temperature areas are within the volcanic zone and the low temperature ones outside it. Geysir is located in a high temperature area with a base temperature of 250 °C. Temperatures of the hot springs are up to 100 °C and there were many signs warning about that. The Geysir geothermal area is about three square kilometres at the surface. THE Geysir is dormant and eruptions are rare, but we saw the other geyser, Strokkur, erupt like five times; about every five minutes. The height of erupting water statues varied but it was usually 25-30 metres high. The Great Geysir could erupt as high as 80 metres but last it erupted in 2016 so we really didn't have the time to wait there.

During the day we also visited Kerid Crater. It is a 55-metre-deep oval-shaped volcanic crater and over 6000 years old. It is part of a group of volcanic hills and is now filled with water. However, traces of volcanism were not quite obvious. The water in Kerid doesn't drain out but rises and falls according to the changes in the water table. Therefore, the crater is said to be a window on the groundwater. Tourists can walk around the rim of the crater on a special path. The time we went there it was a really windy day – not just Finland windy but Iceland windy – and we had to watch not to fall into the crater.

The trip continued to the Gullfoss waterfall where I had a realisation about the power of water listening to the water roar. It seemed if we could harness it the right way through new innovations, there would be so much potential in the motion of the storming water - even compared to how we have utilised it already. In Iceland up to three quarters of all electricity production comes from hydropower and, watching the massive waterflow, only then did I really see the power of water in its full glory. Gullfoss is actually two separate waterfalls. The upper has a drop of 11 metres and the lower one 21 metres. The sight was indescribably breathtaking, and I had never seen anything like it before.

The last stop was at Iceland's only national park – Thingvellir. It is the place where you can stand between the continents, where the North American and Eurasian tectonic plates move apart approximately 2.5 centimeters a year. Thingvellir is also a very important and special place

> "It was impressive since you don't get to see that in Finland

considering the history of Iceland since it is where the Icelanders gathered to discuss the common laws and settle their disputes. A parliament of sort held its annual meetings there as early as in 930. There is also a rather neat waterfall, Öxarárfoss, but we couldn't find a treasure behind it.

During the day we took note of how the Geysir geothermal area, Kerid Crater and Gulfoss were all utilised in tourism. For example, at Geysir we visited a visitor centre where there were plenty of souvenirs for tourists to buy and restaurants for them to go to. Of course, that's kind of the point of it. People expect to face other people too coming there – they are not called tourist attractions for no reason – and they can choose different sights if they want to feel the nature by themselves.

At Golden Circle sites there were also parking lots right next to the sights, which has its pros and cons. Certainly, tourism is very beneficial to the economy and vital to Iceland as a livelihood. It is also great that everyone can visit the sites no matter the shape they are in as the sites are rather easily accessible without too many stairs or too long distances to walk. On the other hand, you don't get that same kind of close-to-nature and peaceful feeling as you would get if the sites weren't packed with tourists. It was even hard to get good photos when there were people everywhere. Fortunately, at least I didn't detect any impolite behaviour and people weren't anxious to wait their turn. Certainly, it has been a rough couple of years for tourism everywhere because of covid so it was great to see that it seemed to be back on its feet.

When I first googled Golden Circle, the entire first page of the results didn't show any information of the sights. There were only advertisements about guided bus tours to the route. That is a great choice for some people (and I bet the trips are fully booked!) but I'm glad we had our rental cars to drive around with. It made the whole tour seem less touristy and we got to stay at the sights as long as we wanted – not having to worry about our bus leaving us. In conclusion, the name Golden Circle is in place – it is a golden opportunity to see many incredible tourist attractions with easy access. The whole day was unforgettable.

Inka Arposalo

"It is great that everyone can visit the sites no matter the shape they are in as the sites are rather easily accessible

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ON THE ROAD AGAIN

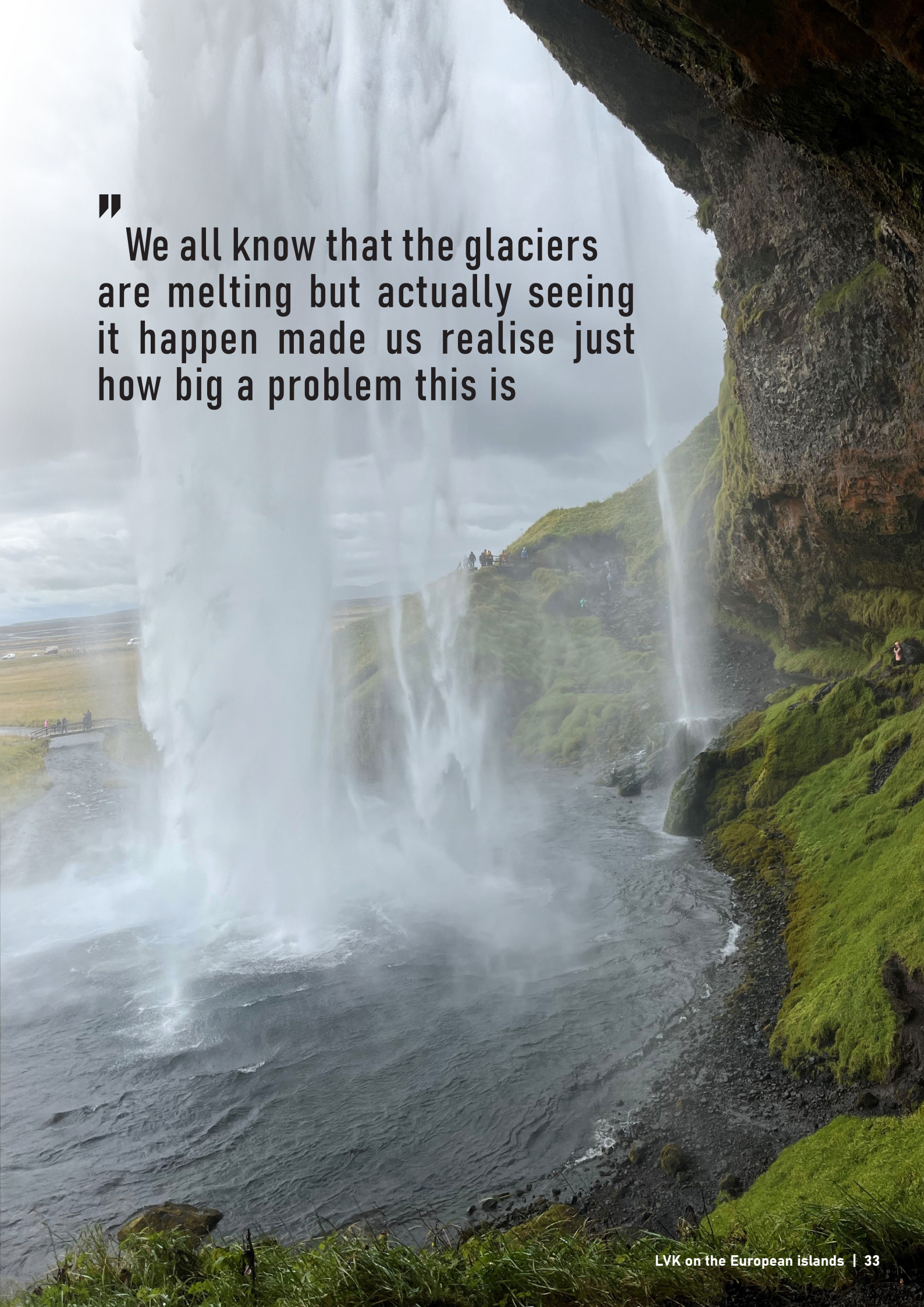
SOUTHERN ICELAND

We started our day early in the morning with a large breakfast, including many pancakes like every breakfast in Iceland, as we knew we had a long day ahead of us. After breakfast we packed our backpacks and headed our party van and Honda to Southern Iceland's best nature sights.

At first the atmosphere was a bit tired, but the first location was a good wake up for all. The first destination was an abandoned thermal swimming pool Seljavallalaug. It is the oldest swimming pool of Iceland, and it was constructed in 1923. Nowadays it is not under any maintenance, so people are free to go and swim in the pool as they wish. The pool is full 25 metres long and has a small changing room beside it. Some of us went to swim in the pool and the water was rather warm. Due to the lack of maintenance, there was also quite a lot of algae and the smell of the water was a bit nasty. So, everyone who went to swim in the pool had to go to wash themselves on the ice-cold river running beside the pool so that our cars wouldn't stink the whole day. After this hot and cold treatment, we continued our day.

The second location was Solheimajökull glacier. The views were amazing as we got to go right beside a massive volume of ice. Most of us hadn't seen a glacier in nature before so the experience was fantastic. We hadn't also thought that it would be so dangerous to walk to the glacier. There were many warning signs telling all the danger one could face when going to the glacier such as quicksand, flood waves or deep crevasses. Another thing that became touchable was the vulnerability of the glaciers. Of course, we all know that the glaciers are melting but actually seeing it happen made us realise just how big a problem this is and also how sad it would be for such wonderful natural wonders to just disappear for good like the glacier Okjökull that was declared dead in 2014.

After the glacier we headed to Reynisfjall black sand beach and the Dyrholaey viewpoint right next to it. Actually, the name black sand beach is a bit misleading, and Icelanders don't really like it. All sand in Iceland is black and so are all the beaches so calling a beach black



"We all know that the glaciers are melting but actually seeing it happen made us realise just how big a problem this is

doesn't exactly identify it. The viewpoint wasn't called a viewpoint for nothing, the views were really cool. There's, for example, the last intact sea arc in there. However, one of the best things or even the best in this location was the overly cute puffin birds. The birds live on the slits and ledges on a cliff, and they were gliding effortlessly back and forth just to show their cuteness to the tourists. We also collected some round rocks from the beach only to find out that if you take them away from the beach, they bring bad luck.

The next locations on our trip were the waterfalls Skogafoss, Seljalandsfoss and Gljufrabui. All of these locations were absolutely stunning, and we took photos straight from a postcard. The waterfalls also made quite a big noise when the huge masses of water came crashingA down. Seeing the waterfalls so close was a really cool experience even though we got really wet from the falling water. Some of us even went into a cave where they had to wade in ice-cold water without shoes to see another waterfall.

After all these amazing locations we drove back to our hotel tired but happy and amazed. This whole day was not only seeing gorgeous sites nature has to offer but also realising that many of these are threatened by global warming. The day gave us motivation for our studies with renewable energy solutions to save and conserve places and animals like we had seen with our own eyes.

Iida Willberg

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EDINBURGH

ATHENS OF THE NORTH

Edinburgh, Athens of the North, is the capital and the second most populous city in Scotland. The city earned its nickname a long time ago due to the similarities in the lay of the land, architecture, and intellectual virtues of the two cities. References to the capital of Greece have been made since the 1700's and even the National Monument of Scotland built in the 19th century directly copied Athens' Parthenon. It is no surprise that Edinburgh's Old Town and New Town together are listed as a UNESCO World Heritage Site. Visiting Edinburgh, it truly felt like culture and history are the two shining stars of the city. This was accentuated by the Fringe festival, which was by chance ongoing at the time.

The Fringe is organised yearly in Edinburgh, and it is the world's largest arts and media festival. It features thousands of shows in hundreds of venues in the span of multiple weeks. Performers and tourists gather in Edinburgh from all over the world to enjoy a world-leading celebration of arts and culture. Many of our days ended with seeing a random performance or show with little to no idea what to expect. No performance left us disappointed. My personal favourites were an improv comedy group from Australia and a jazz concert played in a moody pub in the small hours of the morning. But even though our experience with the Fringe was amazing per se, the amount of people it attracted to the city had its downsides.

It was to be expected that a festival of that size spanning over multiple weeks would generate a higher amount of waste and trash than usual. However, it was not as expected that the bin workers and the trash collectors of Edinburgh were on a 12-day strike. These two facts combined resulted in a flood of trash washing over the whole city. In some places the situation could get really bad but at least the importance of the bin workers became obvious. The Edinburgh castle was also closed for random visitors due to a military Tattoo (musical performance and a display of armed forces), so we unfortunately couldn't get in.

Thankfully Edinburgh was full of other things to see and to do. In addition to the nightly Fringe shows, we familiarised ourselves with the famous pub and whiskey culture of Scotland. Edinburgh also has some nature to offer, as it is not only a lump of historical rock. In addition to the many great parks, the "Arthurs Seat" mountain's top offered us a marvellous view of the whole surrounding city after a nice climb. Even the weather was mostly great for outdoor activities despite the stereotypes about the British weather. And of course, what would a big city be without the proper shopping experience and selection. Edinburgh really had something to offer for everyone.

Big cities can be a bit expensive and that is why we opted to stay in a local student housing. We had two apartments consisting of several 2 person bedrooms and a common area. The apartments had only one shared bathroom and a shower between 7 or 8 people. Noticing the situation, I was glad that we had already travelled together for a week. Surely this wouldn't even count as an obstacle for our group of seasoned travellers.

Tuomas Orava


"It truly felt like culture and history are the two shining stars of this city


OLD TOWN
OLD TOWN HOUSE

VEOLIA


PLEASANCE
ATTIC
PLEASANCE LONDON
CELLAR
CABARET BAR
DAVE


THE OLD


Holyrood Park
2 3
Pollock Halls
Craigmillar
Musselburgh
2 3
2 1/4
6
1
20
Push button
Wait for signal

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GAS COOLED REACTORS

TORNESS NUCLEAR POWER STATION

Our first excursion day in Scotland started on an autumn morning in Edinburgh. We walked from the motel to the city centre and the bus station, from where we took the bus towards Torness. The trip from Edinburgh to Torness took about an hour, so planning the schedule and buying the bus tickets wasn't easy. There is no single operator in Scotland that operates in the same way as HSL in the entire Finnish capital region. However, we managed to find a local operator who drove to Torness directly from Edinburgh city centre. We didn't miss our cars in Iceland for long, because the bus connection worked really well in the end.

After the bus ride we were not able to miss the power station. Our first reaction was a mixture of amazement, admiration and caution. If you have seen a movie about nuclear power, the facade of the power station was exactly what you can imagine apart from the missing cooling towers. When we arrived at the plant gate, we were welcomed by three lovely ladies who worked as our tour guides.

In practice, the type of nuclear reactor is determined by the cooler and the neutron moderator. The cooler stabilises the heat produced by the reactor and transports the heat away from the reactor itself. The moderator reduces the kinetic energy of neutrons to desired energy level by collisions with lighter nuclei, such as water or graphite. All reactors operating in Finland are light water reactors. Fortum's reactors located in Loviisa are pressurised water reactors (PWR), where the primary coolant releases its thermal energy in the evaporator to the secondary steam turbine cycle. Olkiluoto's two old reactors are boiling water reactors (BWR), in which water is simply boiled in the reactor and the steam obtained from it turns a turbine. Olkiluoto 3 is a newer European pressurised water reactor (EPR), which is a third-generation nuclear reactor type.

Advanced gas cooled reactor (AGR) is a second-generation reactor type using graphite as the neutron moderator and carbon dioxide as coolant. One of the biggest differences to the reactors used in Finland is of course the absence of water as a large part of the system. Another significant difference is in the operating conditions of the reactor. In the steam

> "The carbon dioxide coolant gets very hot in the reactor core, which results in high efficiency

turbine circuit, the temperature affects the efficiency, but in BWR the temperature of the circulating coolant is practically limited to the boiling point of water. In PWR, the higher pressure keeps the water as a liquid, and the operating temperature of the reactor is thus higher as well. Gas-cooled reactors do not have a corresponding limitation, which would result from the sensitive change in the state of water. In AGR reactors, the carbon dioxide coolant gets very hot in the reactor core, which results in high efficiency.

There are two identical reactors in Torness and together they produce more than 1300 MW carbon free electricity. As told, both the reactor and the plant differ in many ways from the nuclear power plants used in Finland, so we had a lot to learn. During our visit we were lucky to be able to see some main parts, such as the reactor hall, turbine hall, and control room in direct action. One of the reactors was undergoing maintenance, and as we took a look into the reactor hall we saw a big machine above the reactor deck (cover). It looked like some kind of a construction machine, but our guides specified that there was a refuelling going on so that mysterious machine was a refuelling machine. We were first confused when the reactor produced electricity at about half the power. For example, when refuelling a BWR, the cover of the reactor's pressure vessel must be opened, and before that the plant must be disconnected from the grid and shut down. We were told that the gas cooled reactor can be refuelled during run as only part of the reactor is out of use.

Compared to Finland, the British nuclear power situation is partly similar but also different. The older facilities are getting old and the aim is to continue using them as long as possible. However, reactors in the UK are completely different and so are their pros and cons.

Lifetime is one of the measures of profitability when planning any energy solution. In Finland for example, the use of older light water reactors is planned to continue for decades more. The service life of a gas cooled nuclear reactor depends a lot on the graphite used, which sooner or later begins to crack as the radiation dose increases. Eventually, the cracking and expansion due to heat and pressure starts to affect the core geometry and, for example, the integrity of the fuel and safety functions. During our visit we learned that even though AGR has a relatively good efficiency, the lifetime is not so great.

In Great Britain, a lot of new capacity is needed to replace the end-of-life gas-cooled AGR plants, and to reduce dependence on fossil fuels. We are looking forward to seeing which direction nuclear power technology is going in Great Britain, whether they will seriously start developing small modular reactors or are they going to invest in EPR's for example.

Overall, we were really satisfied with the excursion, it totally exceeded all our expectations. What really made the journey exciting was the fact that for most of us, this visit was the first ever at any kind of nuclear power plant. Our guides were very pleased that they had a chance to hear our traditional Finnish excursion song. After visiting the Torness plant, we were advised to visit a beach just next to the plant area. After visiting the old and partly rugged power plant, the beautiful beach scenery and fresh air were a very nice experience before the long bus ride back to Edinburgh. The return trip was a bit longer, it took almost two hours but at least we were able to see the local infrastructure and scenery also outside of the city.

Kasperi Haapanen

RIDING THE WAVE OF POWER

MOCEAN ENERGY

Similarly to the modern day, there was an energy crisis in the 1970s. Today's energy crisis is largely related to fossil fuels and their availability, which was also the case back in the day when the 1970s crisis was about oil. To overcome the high oil and energy prices in the 70s, alternative energy sources were developed: among them wave power and nuclear fission. Well, today we know which of these technologies won the rival for attention in the 70s but how will the situation change in the future? Will wave power get a fresh wave of interest and will nuclear fission be a banned form of energy generation in more and more nations? That we shall see in the coming years, but let's dive in a bit deeper to what wave power is and how it could fit into the European energy system.

Wave power involves a wide range of technologies that are utilised to harness the energy from ocean's waves. The technology that was introduced to us at Mocean Energy in Edinburgh was an attenuator. To simply describe the attenuator, it is a bar shaped device that consists of two arms that are joint together with a hinge. The hinge has a generator inside. The bar turns freely perpendicular to wave direction and as the waves hit the device, the arms turn up and down, thus creating torsion for the generator. The generator generates energy by numbing the waves. Mocean Energy has one device at the sea and it is located 10 km away from the shore. The device is 20 metres long and it weighs 40 tons. Its average power is 10 kW and the lifetime is over 20 years. To compare this wave power device to a offshore wind turbine for example, they might be in the similar price range, but the wave power device is able to derive much less energy: 10 kW compared to up to 14 MW that offshore wind turbines have. However, it is good to keep in mind that wave power has not been subsidised nor given much public attention such as wind power has had. Wave power has not yet seen the benefits of economies of scale. Furthermore, the energy system needs various different energy sources: there are less sunny or windy seasons, when wave power can be employed instead of other renewables.

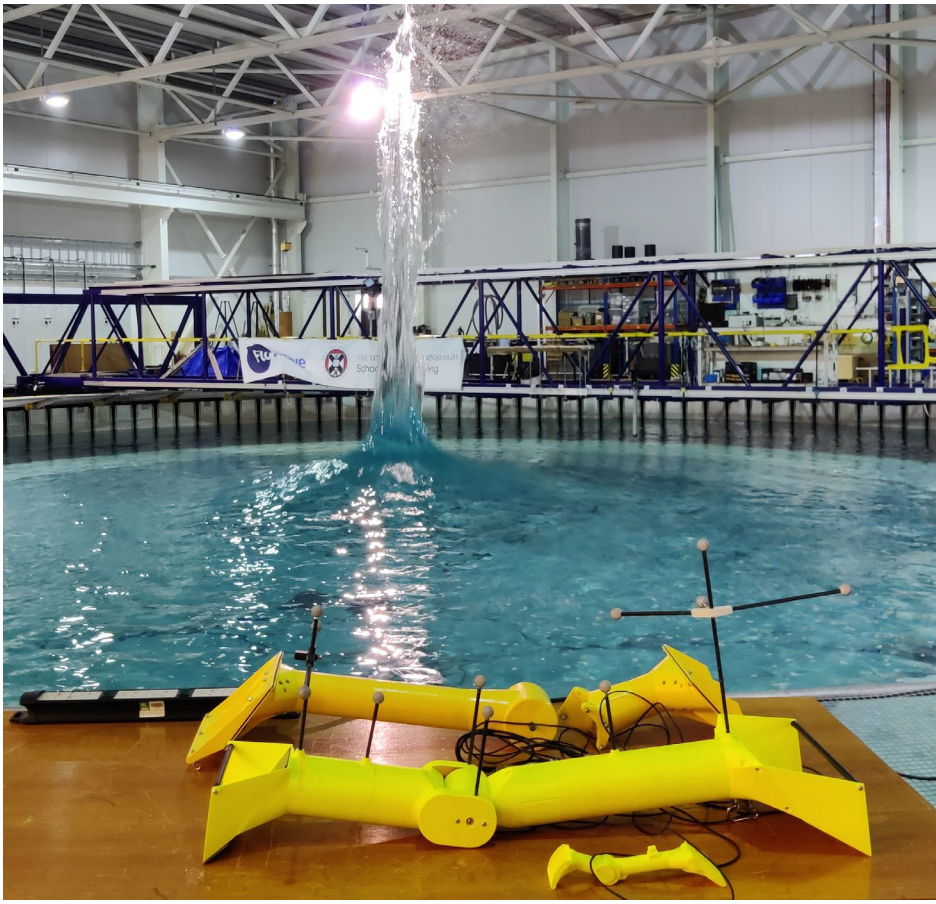
But how would wave power fit into the European energy system? The west coasts are always the sweetest spots for harnessing wave energy. This is a combination of earth's rotation and the global winds that blow from west to east. The best wave power density in Europe is at Ireland and Scotland's west coasts, but Norway and Spain also have decent wave power conditions. However, these countries have not been among those that have taken the hardest hit from the current energy crisis. Thus in order to alleviate the energy shortage in Central and Eastern Europe, an effective and strongly interconnected transmission system should be constructed across Europe. Luckily for wave power, this seems to be the intention of the EU anyway, at least according to their interconnection targets. Thus there could be a feasible place for wave power on the west coasts of Europe. On the bright side, wave power does

> "Wave power involves a wide range of technologies that are utilised to harness the energy from ocean's waves

not really cause any visual disturbance nor harm sea life. However, similarly to other renewable energy sources, wave power is intermittent and dependent on winds.

Our visit to Mocean Energy's testing pool showed us that the durability of the wave power devices is really set to test. The research and development centre had a computer controlled testing pool in which harsh sea conditions could be imitated. It became clear that no details are left to chance when designing these wave power devices: they have to withstand great stutters and a corrosive environment for decades while requiring as little maintenance as possible. When the waves become overwhelming, the device's survival strategy is to turn off the generator and let the hinge turn freely. This kind of research is highly important as the sea conditions seem to become more and more extreme with climate change.

Sonja Nurmiainen



CATAPULTING RENEWABLES TO NEW SPHERES

OFFSHORE RENEWABLE ENERGY CATAPULT

Wind power is evidently one of major forms of energy already and its role is getting even more important in the future. In fact, the installed capacity worldwide is almost exponential. The British Isles have great wind potential, and it is no surprise that over 25 % of electricity produced in the United Kingdom is from wind power. Scotland is a couple years ahead of Finland in terms of installed renewables capacity. This can be seen when comparing the installation graphs of the countries (below) in which Finland is going in a very similar looking direction, although a decade later than Scotland. The amount of wind power could also be noticed in person. As we travelled through Scotland via bus or train, we could almost always see a turbine or two in the horizon.

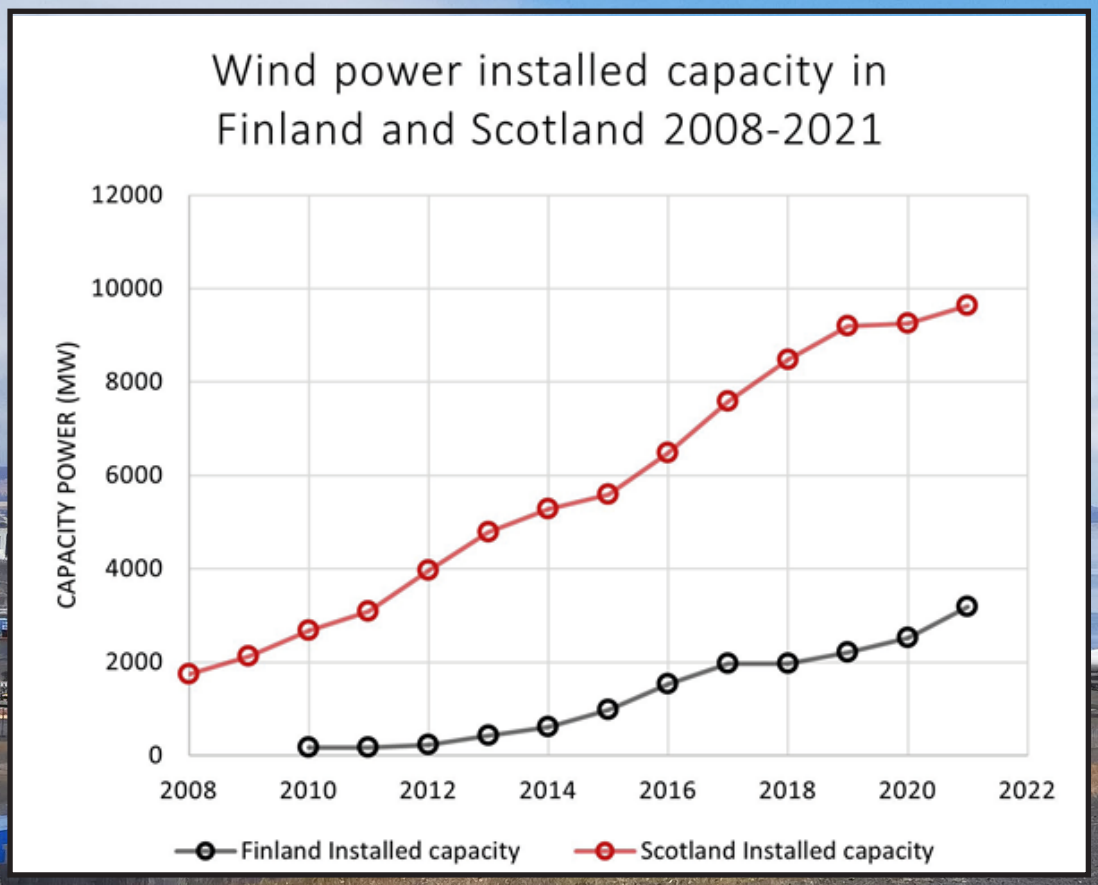
Due to its location, the British Isles have great wind resources, which is partly the reason for the countries' big wind power fleet. We in Finland are a couple years behind but our wind power capacity will see a similar increase in the coming years.

Wind farms require numerous studies and analyses for determining the best location for turbines. This is where Offshore Renewable Energy (ORE) Catapult's Levenmouth Demonstration Turbine steps into the picture.

The company owns the world's most advanced, open-access offshore wind turbine dedicated to R&D. Connected to the land by a walkway, the turbine allows developers to demonstrate new systems and methods – without the associated time and costs of conducting tests at a working offshore wind farm. Some of the research projects include yaw-changing according to optimal wind conditions using LIDAR-systems and testing maintenance robots that can perform difficult tasks on the turbine blades.

The research focus is in fact quite significant as this turbine is the only offshore turbine that third party researchers can use to conduct their own research. Due to different parties having their own test focuses, the turbine has more downtime and maintenance done to it compared to a common wind turbine. This also means that the turbine's capacity factor (actual production divided by theoretical maximum) is closer to 25-35 % instead of 40-45 % that typical production focused wind farms have. The lower capacity factor can in practice be explained by maintenance breaks and configuration adjustments between different test arrangements.

The turbine has quite an array of additional measuring apparatuses not found on standard wind turbines.



This equipment allows the user to examine blade, tower and substructure behaviour. Having these as part of the turbine means that a digital replica of the turbine can be created and studied, which is not possible with typical wind turbines.

In addition to offshore wind, the ORE Catapult also focuses on other offshore energy sources, including wave and tidal energy. Tidal energy especially was a favourite of our hosts, since Scotland has the greatest tidal potential in Europe. Tidal energy also differs from other offshore energy sources since its predictability means that it can be used as a baseload.

Tidal energy, as the name suggests, uses the tidal forces of the sea, which are exceptionally great near the British Isles. As the tidal waves flow inland or back to the sea, a generator much like a hydro power dam converts the energy of the waves to electricity. Since the waves follow the movement of the moon, the power production is very predictable. Unfortunately for us in Finland though, we have practically no tidal potential.

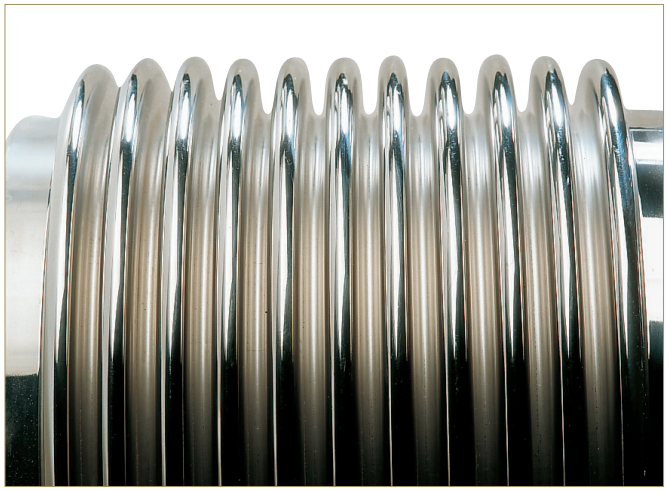
One of the driving factors for offshore wind, alongside increased capacity factors, is the lack of suitable locations onshore. Finland is a big and sparsely populated country. Therefore, we have a lot of space for common onshore wind power farms which are currently the cheapest electricity production technology. Still, every project on-shore is a step closer to offshore wind power to become economically viable even without subsidies. Finland has no such facility to test different technologies and solutions and the Finnish wind power industry can learn much from our Scottish colleagues so that we can be ready for the offshore era.

Markus Manninen

> "One of the driving factors for offshore wind is the lack of suitable locations onshore

Tarjoamme ratkaisuja putkistojen ja laitteiden lämpöteknisiin tarpeisiin

Metallipaljetasaimet ja metalliletkuasennelmat omasta tuotannosta
Valmistamme tuotteemme mittatilaustyönä asiakkaiden käyttötarpeiden mukaan Masino Industryn tehtaalla Ylöjärvellä.



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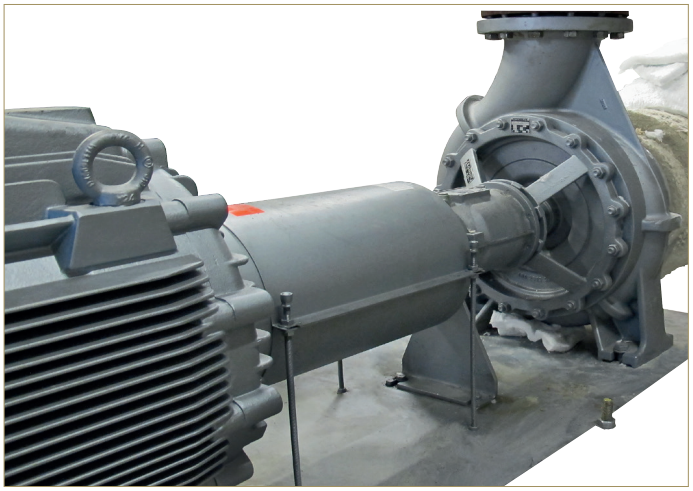

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Haastattelussa Lämpövoimakerhon alumni Otso Manninen

Mitä olet opiskellut yliopistossa?

Aloitin energiatekniikan opinnot TKK:lla 2007 ja valmistuin diplomi-insinööriksi Aallosta 2015. Maisterivaiheessa pääaineeni oli energiatalous ja tein myös vaihto-opintoja ETH:lla Zürichissä Sveitsissä.

Kuinka aktiivinen olet ollut Lämpövoimakerhossa?

Opiskeluaikoina kävin aktiivisesti LVK:n tapahtumissa ja olin mukana ulkoexcursiolla Etelä-Amerikassa 2012. Kerhon raadissa (nykyään hallitus) en koskaan ollut, sillä olin aktiivisempi killassa. Joskus harkitsin raatiin lähtemistä ja välillä minua on harmittanut, ettei tullut lähdettyä. Siksi olikin helppo vastata myöntävästi, kun minua kysyttiin Lämpövoimakerhon Senioriklubin raatiin. Aloitin sennujen raadissa 2019 ja olen toiminut jäsenrekisterivastaavana sekä sihteerinä. Yleisesti voin suositella opiskelijayhdistyksissä toimimista, sillä niissä pääsee harjoittelemaan monia työelämän juttuja turvallisemmassa ympäristössä.

Kerro vähän urastasi ja miten päädyit Fortumille?

Ensimmäiset oman alan työni sain voimalaitokselta, jossa työskentelin pari kesää. Vaihdon jälkeen pääsin Sveitsissä työharjoitteluun Axpolle muutamaksi kuukaudeksi ja kun työsopimukseni päättyi siellä perjantaina, aloitin seuraavana maanantaina kesätyöt Fortumilla turbiinimallinnuksen parissa. Paikan saamisessa lieni apua siitä, että kerroin nähneeni aiemmissa kesätöissä voimalaitoksen vuosihuollossa turbiinin avattuna. Kesän jälkeen jäin tuntitöihin, tein Fortumille myös diplomityöni ja jäin sen jälkeen vakituiseksi työntekijäksi.

Mitä olet Fortumilla päässyt tekemään?

Pian valmistumiseni jälkeen minua pyydettiin juuri perustettuun Nuclear Services -yksikköön. Vaikka en pitänytkään itseäni ”myyjänä”, päätin astua epämukavuusalueelle ja tarttua tilaisuuteen. Siitä lähtien olenkin työskennellyt kyseisessä yksikössä, tosin useammalla eri tittelillä. Olen päässyt mm. kehittämään työkalujamme ja prosessejamme sekä vastaamaan Posivan asiakkuudestamme. Nyt vastaan yleisesti myynnistämme. Myymme ja toimitamme erilaisia ydinvoimaan liittyviä palveluita ja tuotteita. Olemme esimerkiksi mukana purkamassa Otaniemen koereaktoria ja NURES-teknologiaamme on käytetty puhdistamaan Fukushiman radioaktiivisia vesiä.

Mikä on parasta työssäsi?

Työ on vaihtelevaa ja projektiluontoista, joten eri projekteissa on päässyt näkemään erilaisia asioita ja vielä eri maissakin. Työmatkat ovatkin työn parhaita kokemuksia. Pääsin myös tutustumaan Onkalon loppusijoitustiloihin ja katsomaan, miltä sen tunnelit näyttävät ja miten loppusijoituspaikat rakentuvat.

Mitä vinkkejä antaisit nyt opiskeleville?

Jos ei ole varma siitä, mikä itseään kiinnostaa, on hyvä käydä peruskursseja ja sitä kautta saada yleiskuvaa alasta. Ja vaikka tietäisi, mihin haluaa erikoistua, kannattaa avoimin mielin opiskella myös asioita, jotka eivät itselleen ole niin vahvoja tai joita ei muuten kuin yliopistossa tulisi opiskeltua. Esimerkiksi voi valita pari kurssia ohjelmointia, vaikkei koodariksi aikoisikaan tai jonkin muun kaupallisen kurssin.

Onko sinulla antaa vinkkejä kesätyönhakuun?

Fortumin ydinvoimapuolelle otetaan paljon kesätyöntekijöitä. Hakemuksessa kannattaa pyrkiä tuomaan ilmi motivaatio ja kiinnostus; opiskelijoilla kun taustat ovat yleensä varsin samankaltaisia. Yleisestikin kannattaa hakea rohkeasti, vaikkei tuntuisikaan, että täyttää kaikki vaatimukset. Kesätyöt ovat kuitenkin opiskelijoille tarkoitettuja. Joskus voi myös olla kannattavaa soittaa rekrytoivalle taholle ennen hakemuksen laatimista, minkä jälkeen voi esimerkiksi räätälöidä hakemustaan paremmin kyseiseen paikkaan.

Faktaboksi

Kuka:
Otso Manninen

Työtehtävä:
Senior Manager, Sales and Marketing, Nuclear Services, Fortum

Opinnot:
DI 2007-2015, KTM 2013-2018

Diplomityö:
Economic analysis of nuclear safety investments: reactor cavity flooding system

Paras muisto opiskeluajoilta:
LVK:n ulkoexcu 2012 + vaihto-opinnot

ABERDEEN

THE GRANITE CITY

Aberdeen, also known by the nickname “granite city”, is the third most populous city in Scotland. The city is also often called the “oil capital of Europe” due to its large oil and offshore industry in the North Sea. This northernmost major city of the United Kingdom has over 8000 years of history and culture to offer, which can be experienced by visiting the old castle-like universities and listening to the bagpipe music played by the buskers on the streets.

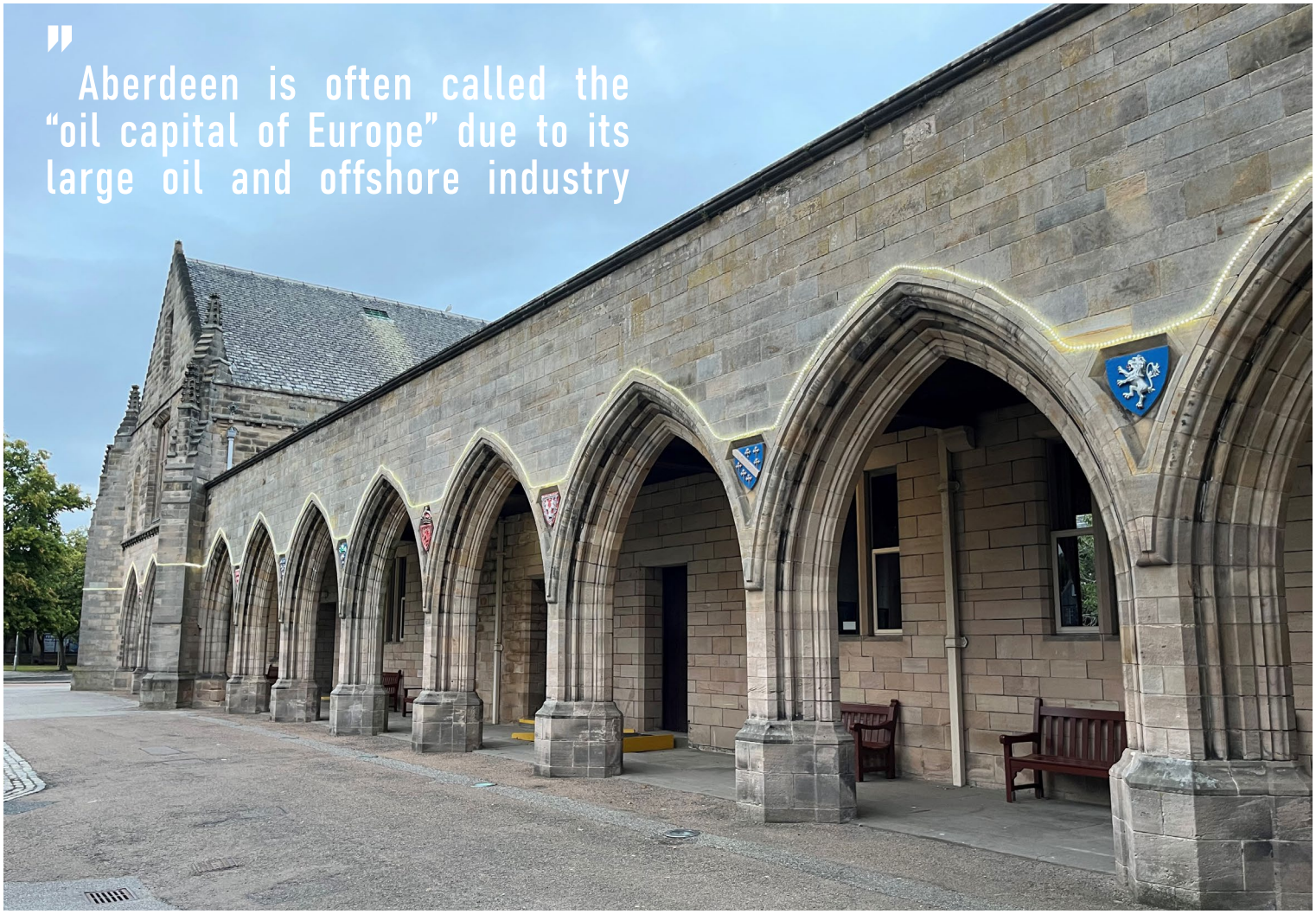
Even though Aberdeen is quite a big of a city, it has about half the number of residents compared to Edinburgh. This could be felt immediately after leaving the railway station and seeing the comparatively empty streets of Aberdeen. The feeling of being in a smaller city was also enhanced by the narrow streets and tight layout of the city grid. Aberdeen being a smaller city was, by no means, strictly a bad thing. For example, our hotel was really affordable compared to its quality and atmosphere. The streets were also cleaner, and it felt like we had more room to move around with our bigger group.

Walking around Aberdeen, it is easy to understand where the city’s nickname “granite city” came from. Locally quarried granite is the main building material of Aberdeen. This, along with the often grey colored sky, gives the city its noticeable dullness and melancholy. At first, this can make the architecture feel a bit boring. However, the more you actually focus on the buildings, you notice the charm of the detailed old-timey facade. The monotone colour scheme and the baronial architecture truly make the city feel really historical and quite imposing.

In a smaller city, the interactions with people feel more personal. Some of the locals asked us to turn up our music and one of them even agreed to film our little dance performance in a small town square. Majority of the people we interacted with on the streets seemed pretty relaxed and friendly. It was a bit different story with the customer service we experienced though. It almost felt like there was prejudice against us because of our young age. In retrospect, it is understandable that the hotel staff is a bit wary of a large group of young tourists. Thankfully, the full English breakfast that was offered at the hotel every morning managed to lift our spirits every time.

All in all, the impression that Aberdeen left us with was positive. Due to us not having that much scheduled plans for the evenings, we could spend our time more freely exploring the city’s sights, pubs, and restaurants. Afterall, you can’t really go wrong with fish & chips and a pint of Guinness.

Tuomas Orava



EVOLUTION OF THE OFF-SHORE INDUSTRY

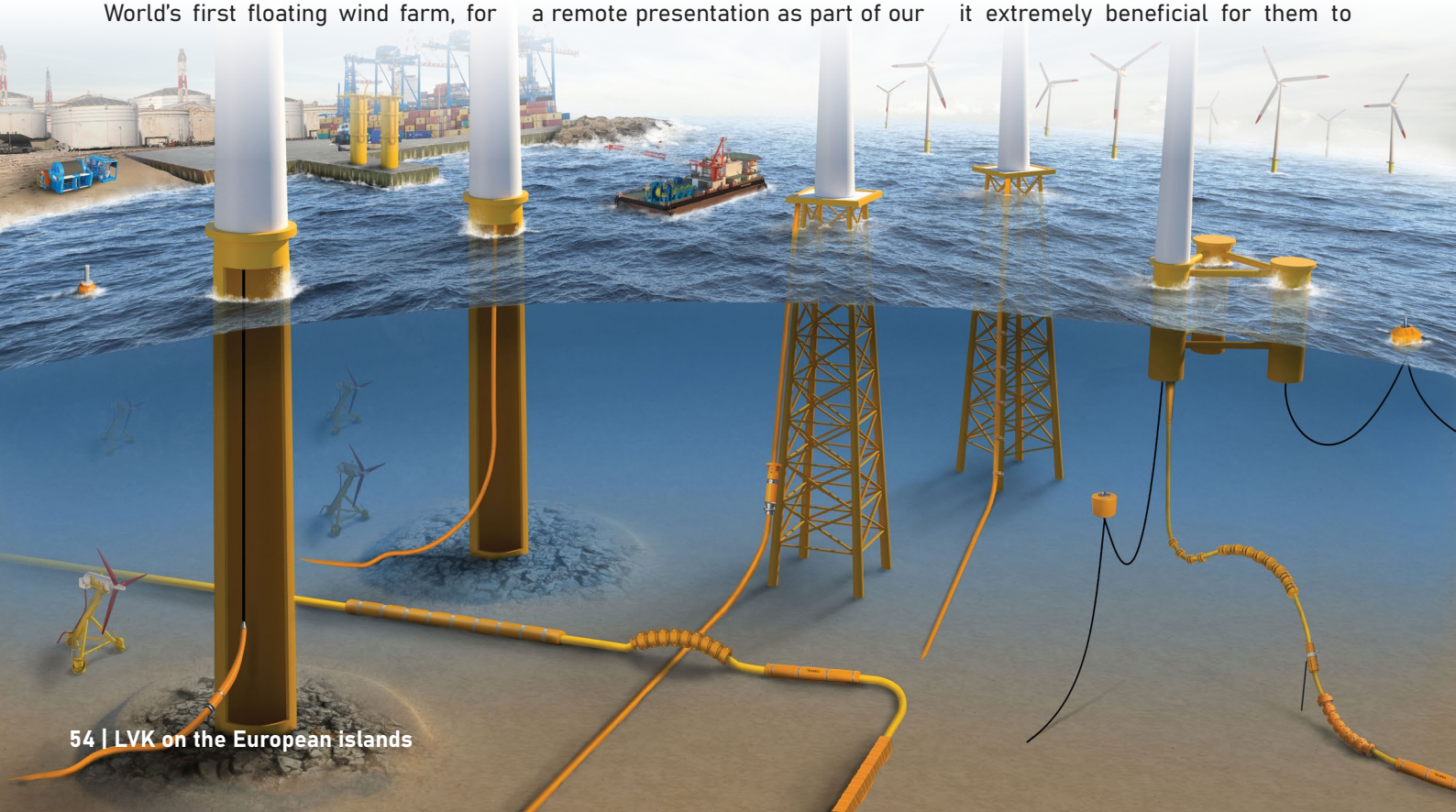
BALMORAL

Edwin Drake's oil well drilled in 1859 is widely seen as the first modern oil well marking the beginning of a new era. The versatility and convenience of oil quickly led to local oil booms and the pursuit of black gold, which quickly extended to the offshore environment. Oil was drilled in ocean waters already within the 19th century, whereas the first offshore oil rig began its operation in 1947. The development quickly enabled drilling in ever deeper waters with the current records approaching three kilometres. Indeed, a lot has been invested in oil and the technology used to extract it. As a result, to this day, we are dependent on oil for almost 30 % of our primary energy consumption whilst non-fossil energy sources account for roughly 23 %.

Luckily, the technology developed for offshore oil production can also serve renewable energy production at sea. Therefore, it is not surprising that many of the largest oil companies have plans regarding offshore wind. World's first floating wind farm, for example, was developed by the Norwegian oil giant Equinor and started operating in 2017. The players in the offshore industry, however, are not limited to the oil giants. There are, for example, a number of manufactures that have served the offshore oil industry, gaining expertise in the offshore business and knowledge of the harsh environment. And it is no surprise that these companies are also targeting the renewable offshore energy industry. After all, the capacity is growing rapidly – a recent seabed auction resulted in a combined generating capacity of 25 GW of offshore wind in Scotland alone.

> "It is important to have robust components that endure the harsh conditions

One of the companies targeting this vast market is Balmoral who gave us a remote presentation as part of our group has got sick. Fittingly, the company is headquartered in Aberdeen, the oil capital of Europe since oil is also where Balmoral has its roots. They have manufactured a variety of products for the offshore oil industry for over four decades. More recently, they have provided their solutions to the renewable power sector as well. Balmoral is focused on offshore cabling which, I guess, doesn't differ that much between an oil rig and a wind farm. Of course, there are differences in the way these structures behave and that results in different requirements for all the components as well. I'd still argue that Balmoral has been able to offer the same products with different dimensioning and small modifications making it extremely beneficial for them to

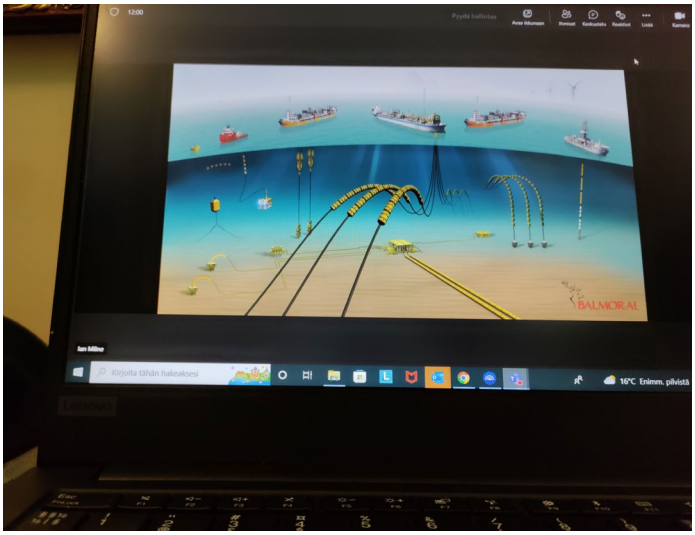


gain the renewable offshore energy industry as their client.

But what exactly are the "cabling products" and why are they so important? To understand the importance, we must first understand what the offshore environment is like. Imagine you have to go change a fuse on onshore and offshore wind turbines. The onshore turbine is not a problem, you can take a car and park it right next to the turbine. For the offshore turbine, however, the changes are you might have to wait a day or two for the sea to calm and take a boat, which might also be pretty hard to park at the turbine's foundation. You get the point; it's time consuming, difficult, and dangerous to work offshore – even if you don't have to go below the surface. The environment is also corrosive and in constant motion due to waves, currents, and tides. To sum everything up, it is expensive to move at the sea, which is why it is important to have robust components that endure the harsh conditions.

That's where the cabling products come in. Balmoral provides different kinds of stiffeners, buoyants, protectors, ballasts, and insulators that aim to prolong the lifetime of the cables. Basically, it all comes down to reducing the unwanted motion of the cables and increasing their ability to stand the motion. Most of us probably have had the charging cable of our phone broken. They usually break down near the connector since they can't endure the motion and bending. This is exactly what Balmoral's products prevent from happening – on a larger scale. If you know how annoying it is to realise your phone charger doesn't work anymore, you can just imagine how the wind farm operator must feel if their cables fail prematurely – and how much they have to pay to fix it.

On top of the reduced costs, the longer lifetime of the cables is also better for the environment. Naturally, less resources are used since components don't need to be replaced. Furthermore, this also reduces the need for maintenance and therefore the O&M related fuel consumption as well. Even with renewables, it is important to consider the environmental impacts, which is why I was delighted to hear that Balmoral has studied the microplastic formation of their products. The results are also delighting as well as intuitive: the reduced motion of the cable means less rubbing against the seabed and since the rubbing causes the plastic to shear off, Balmoral's products can reduce the formation of microplastics. Indeed, it is important to study and be aware of all the impacts one might have on the surroundings. After all, we don't want a solution to cause a new problem.



Offshore energy production will play a crucial role in the carbon free energy production for several countries. It is essential to ensure that the technology and the resources invested in the industry are used optimally. This means, for instance, that the downtime should be minimised. This is achieved with different kinds of solutions, including the ones many of us typically overlook as we gaze upon the enormous rotors and towers, such as Balmoral's cabling products. Furthermore, as these products (and many others) were already developed for the offshore industry before even the first offshore wind turbine was built, we can only imagine how far behind we would now be in utilising renewable offshore energy if the technology hadn't been developed for the oil industry. Indeed, it is only fitting that with all the problems oil production has brought, it has also produced means to harvest renewable energy at sea.

Eetu Laitila

MADE FROM SKY TO SCOOP

MACKIE'S OF SCOTLAND

Our last excursion of the 2022 abroad excursion was somewhat different from all of the previous ones. That is, the company we visited was not operating mainly in the energy industry, but in the food industry. In recent years many companies outside the energy industry have started to invest in their own renewable energy production. In the United Kingdom, one of the first was a Scottish ice cream and chocolate manufacturer called Mackie's of Scotland. The company has covered their entire ice cream and chocolate production with their own wind and solar power production. As a matter of fact, they produce twice as much renewable electricity compared to their own electricity consumption.

Mackie's of Scotland invested in wind power back in 2005, buying three 850 kW Vestas wind turbines. These turbines are directly connected to the company's production facility. The installed capacity of the wind turbines amounts to 65 % of their ice cream production facility's energy consumption. The rest of the electricity for the production facility is bought from the grid. The company later expanded their renewable energy production with a 7000 panel, 1,8 MW solar farm and a fourth wind turbine. Altogether the installed capacity of their wind turbines and solar farm is around 5 MW. The capacity factor of the wind turbines has been around 33 % and 11 % for the solar panels, respectively.

Mackie's of Scotland has also faced some setbacks when investing in renewable energy. For example, the company had to invest in a smaller wind turbine despite larger ones being on sale in 2015 because of the Scottish authorities. It was required that the hub height of the newest turbine should be roughly the same height as in the older turbines in the area to avoid visual landscape nuisance. Moreover, as the wind turbine size had increased dramatically in a 10 year timespan, the company had to invest in a turbine whose rated power was larger than the company's available grid connection capacity. The solution to this was to limit the maximum power output of the wind turbine with a software. Additionally, due to the grid connection capacity limitations, electricity production of the solar farm and the newest wind turbine is sold directly to the electric grid, meaning that the company is currently buying their own production from the grid. The long-term solution to this would be to build a direct connection to the company's production facilities and sell the excess electricity after their own consumption is met. However, long queues to get a grid connection permit from the authorities have created a bottleneck for this plan. Due to this, 75% percent of the produced electricity is directly sold to the grid. Nevertheless, the investments in wind and solar power along with two biomass boilers have made the company into a net producer of renewable energy.

Mackie's of Scotland is quite vertically integrated as a company. In addition to being self-sufficient with their own energy production, Mackie's of Scotland is also quite self-sufficient in their agricultural production. The

company grows the feed for their 300 cows that produce most of the milk for the company's ice cream production. They also store the cows' manure in a slurry lagoon to be used as a fertiliser. The slurry is drained on the fields through a 4-mile-long pipeline system after harvesting season. This is of course both more economical and more environmentally friendly than using industrial fertiliser products. The company has made a great effort in climate actions by aiming towards comprehensive self-sufficiency. However, they do not intend to expand their product repertoire with non-dairy products. The company representative explained that the whole business model revolves around dairy milk at the moment and expanding the product repertoire would require large investments in new production lines. However, the company has studied the correlation between the cows' diet and the methane emissions they produce to find a healthy diet for cows that reduces the methane emissions they produce.

Mackie's of Scotland has been a pioneer in the UK in striving for self-sufficiency with renewable energy. Solving the ongoing human-induced climate change requires systemic change and companies striving for self-sufficiency with clean energy are making a great step in the right direction. However, many more similar stories are yet to be written and the world needs to hear them.

Onni Tikkanen

> "They produce twice as much renewable electricity compared to their own electricity consumption

A huge leap into a carbon-neutral future

Oulun Energia intends to achieve carbon neutrality in its energy production by 2035, simultaneously boosting the circular economy. Its new Laanila biopower plant in Oulu, Finland, features maximum fuel flexibility and high utilization of various side streams.

TEXT Marjaana Lehtinen **PHOTOS** Klaffi Tuotannot Oy

Located in the Laanila industrial park in the capital of northern Finland, Oulun Energia's biopower plant started its commercial operation in November 2020 and plays a vital role in the company's goal of going carbon neutral. It also allows the growing energy demand in the region to be met. The plant sustainably produces 75 MW of electricity and 175 MWth of district heat, as well as process steam for nearby industrial sites.

Valmet delivered a multifuel boiler, flue gas treatment plant and plantwide automation system to Laanila. "The project went according to plan, thanks to Valmet's experienced people, who always know what they're doing," says Jukka Salovaara, project Director at Oulun Energia.

The feeling of successful cooperation is mutual. "It was great to work with the customer's professionals. They have extensive experience in the power plant sector. The project also included new technology, and the customer greatly contributed to its implementation with their views and experiences," points out Harri Limo, Project Manager at Valmet.

Fossil fuels to be removed from the fuel mix

The heart of the plant is a Valmet CFB Boiler, which utilizes circulating fluidized bed technology and is known for its high fuel flexibility. The boiler at Laanila runs mainly on biomass such as wood residuals, wood chips, sawdust and stump chips. Other fuels include peat and solid recovered fuel (SRF) from Oulun Energia's nearby Rusko waste-sorting plant.

The boiler has a steam-generating capacity of 194 MWth at 120 bar, 540 °C. It is possible to increase or decrease the steam parameters, which further adds to flexibility if the fuel mix changes. "Our fuel mix now consists of 70 percent biomass, 15 percent SRF and 15 percent peat. In future, we plan to gradually stop using peat and increase the share of SRF to 30 percent. We're currently conducting a study with Valmet on utilizing SRF more in our process," adds Salovaara.

Waste becomes an asset

Oulun Energia's drive for sustainability and the circular economy extends to the process's side streams. For example, there is an ongoing development project with Valmet on the utilization of ash. The aim is to study how to alter ash quality through combustion conditions, additives or post-treatment so that it can be used in forest or agricultural fertilizers or road construction. What used to be a cost may one day become an asset and a new source of revenue.

Flue gas cleaning is another example of the utilization of something that was previously considered waste. Valmet's flue gas cleaning system does a lot more than enabling the plant to fulfill stricter emission requirements. A flue gas condenser included in the system generates an additional 55 MWth of district heat, increasing the plant's energy efficiency and district heating capacity. Even the water condensed from the flue gas moisture is purified and utilized as makeup water for the boiler and district heating system.

The entire plant is fully equipped with Valmet's advanced automation to control and support operations.

In the picture (from left): Milena Rodriguez, Product Engineer, and Sami Ojala, Product Sales Manager, from Valmet and Jukka Salovaara, project Director from Oulun Energia.

The heart of the plant is a Valmet CFB Boiler, which utilizes circulating fluidized bed technology and is known for its high fuel flexibility.

Automation optimizes production efficiency

The entire plant is fully equipped with Valmet's advanced automation to control and support operations. Valmet delivered Valmet DNA automation, safety and information management systems, including applications for emission monitoring and power plant key performance indicator (KPI) calculations. The plant-wide automation system and Valmet Industrial Internet applications make it possible to optimize the use of the entire system in real time.

The Valmet DNA automation solution enables the company to connect its Laanila plant with its Toppila power plant and optimize its energy production efficiency.

> "What used to be a cost may one day become an asset and a new source of revenue."

Zero unscheduled shutdowns

In addition to high energy efficiency, high availability and reliability were among Oulun Energia's goals in making the investment. Valmet's delivery checked the box. "Since start-up, we've had no unscheduled shutdowns. The availability of both the boiler and the flue gas cleaning system has been very good," concludes Jukka Salovaara.

Oulun Energia's biopower plant started its commercial operation in November 2020 and plays a vital role in the company's goal of going carbon neutral.

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WARM THANK YOU TO OUR SPONSORS WHO MADE THIS EXCURSION POSSIBLE

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Wega Group

We also received a grant from Lisi Wahls stiftelse and raised money by helping our alumni taking care of their forests and participating in the traffic control for the Helsinki City Running Day.

We are beyond grateful for all the support and funding from the industry. Year after year it is delighting to see that the future experts are valued and given opportunities to see and learn things in real life!


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VEOLIA

WEGA

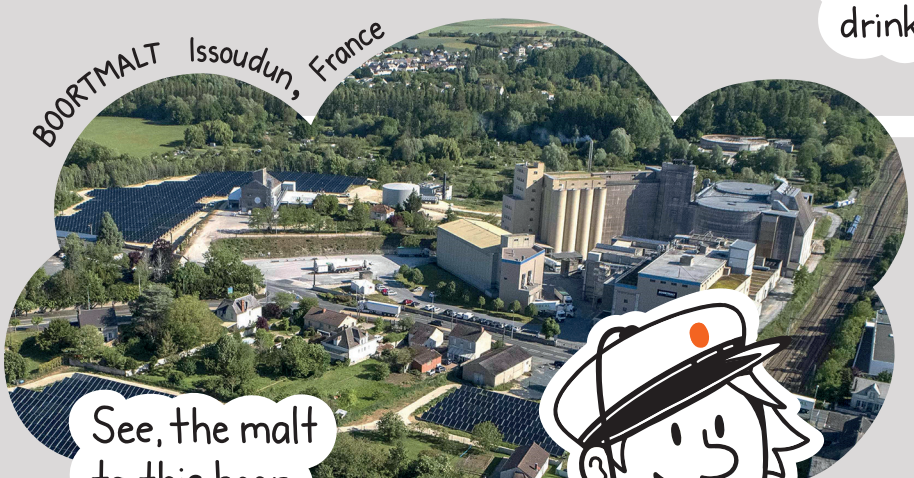
GREEN is the new taste!

by Savosolar

Hey! Have you tried this new green beer?

Green beer? It sure doesn't look green to me!

How many did you drink already..?



See, the malt to this beer has been dried with SOLAR HEAT.

Oh, I see!

Hah, I'm glad you see it now!

CHEERS!

What's green does not always look green!