GREEN IMPACT TECHNOLOGIES

How Danish businesses are using emerging technologies to drive green transition

FEATURED ARTICLES

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We might be closer to solving one of the world's greatest challenges than we think

CAMILLA RYGAARD-HJALSTED
CEO, Digital Hub Denmark

In Denmark, more than 35% of the energy that is consumed nationwide derives from renewable sources. Since the late 1970s, companies with Danish roots – like Ørsted, Vestas, and Siemens Gamesa – have been pioneers in the areas of onshore and offshore wind energy. Of the industrialised countries in the OECD, Denmark produces almost twice as much wind energy per capita as the second-placed country.

Given the country's ambition to become climate neutral by 2050 – i.e., less greenhouse gas is emitted than absorbed – it is an opportune time for new greentech ventures to reach their massive growth potential and work towards a sustainable future.

According to the World Economic Forum's 2019 *Global Competitiveness Report*, Denmark ranks among the top countries in green technology, thanks to the talent pool, innovative and collaborative culture, and ground-breaking ideas emerging from both start-ups and academic-industry partnerships.

In this magazine, you will be introduced to frontrunners in the Danish greentech space and learn about their proposed solutions. Though we in Denmark pride ourselves on having the most innovative mindsets and top talents in the world, we must nurture them to keep it so. Barriers like the lack of funding and international collaborators are hindrances to our ability to take full advantage of the industry. Breaking barriers and creating new opportunities for the public and private sectors to work together towards further funding and knowledge exchanges would foster an environment in which researchers and developers can help solve one of the world's greatest challenges – global warming – whilst creating more jobs, stimulating the economy and fostering healthier lifestyles.

As you dive further into the cases presented in this publication, we ask you to consider how we best solve these issues, develop the talent and make companies realise their full potential.

It falls on all of us to work together in order to stimulate innovation in green technology.

DIGITAL HUB DENMARK PR PHOTO

GREEN IMPACT TECHNOLOGIES ACCELERATING ACROSS ECOSYSTEMS

Denmark is number 1 in Europe and number 4 in the world in terms of ease of doing business. In the context of green impact technologies and business solutions, there is growing momentum in Denmark.

A green economy is increasingly accepted as a key driver in tackling climate change, sustainable growth, poverty, pollution, health issues, and other critical challenges in order to improve life on this planet and for its people. To some, this may seem like a bold statement, but as we will see, mindsets are shifting, policies are being rethought, investments are being redirected and innovation is ourishing.

This is not to neglect the indisputable challenges that our societies, business leaders and policymakers are faced with. Rather the point is to acknowledge that even considering a long and testing road ahead, we are experiencing a new momentum where entrepreneurs and business ecosystems are also placing themselves at the forefront of the green transformation. Perhaps, nowhere is this more evident than in the Nordic countries, which continue to pursue ambitious sustainability targets and provide policy support for green growth across sectors[1].

As with most historical transformations of our economy, the role of technological innovation is central. This time around is hardly an exception. Rapidly emerging digital technologies like arti cial intelligence, machine learning, virtual and augmented reality, blockchain and the internet of things, to name just some of the most prominent, have moved far beyond the initial hype cycles to create a multitude of use-cases and deliver real value for consumers, citizens, entrepreneurs and governments.

Also witness the proliferation of X-tech concepts like greentech, cleantech, envirotech, impact tech, tech for good, responsible tech, and so on. All indicate a growing recognition that technology has never been an end in itself; developing new technologies in the service of greater societal challenges means harnessing technology's full value. Inventor and futurist Buckminster Fuller famously said: "Humanity is acquiring all the right technology for all the wrong reasons". It seems a new generation is out to prove him wrong.

GREENTECH INNOVATIONS

Other examples of greentech include innovations that create clean energy, produce animal-free meat, conserve and repair natural resources, come up with zero-emissions transportation solutions, or produce smart buildings that utilise data sources to optimise energy consumption or recycle materials.

WELCOME TO THE GREENTECH ERA

We call greentech the intentional use of science and technology to benefi our environment and the planet. More speci cally, it refers to technologies that have a low-to-zero negative impact on the environment when we consider their production processes, their supply chains, and the extended environmental impact of, say, a digital service or solution, like how a digital application can shift consumer behaviour in a sustainable direction by reducing food waste. Although early examples of greentech like windmills, were not necessarily digital, the current stage of innovation is predominantly based on digital systems and applications. The list of greentech innovations is growing rapidly, and it is becoming easier, if not necessary, to begin to imagine it having a broad impact across all sectors of *The Fourth Industrial Revolution*[2].

And there is more. Across many of these greentech innovation domains, an added layer of ntech services is driving sustainable investments by expanding the access to capital for start-ups and scale-ups, while allowing many more individuals to invest in green solutions. In these cases, ntech becomes a way of *unlocking green finance* in a new and powerful way.

GREEN ACCELERATION ACROSS DIGITAL ECOSYSTEMS

To support the digital transformation of the Danish business landscape, and the growth of start-ups across sectors, the private-public partnership Digital Hub Denmark was launched in 2018 with the vision of making Denmark a digital frontrunner in Europe by 2023. One of its initial tasks was to identify and map digital innovation

[1] *Denmark ranks number 1 in the Green Growth Index for 2020. See http://greengrowthindex.gggi.org/?page_id=2816*

[2] *See https://www.weforum.org/agenda/2020/01/its-time-for-the-first-green-industrial-revolution/*

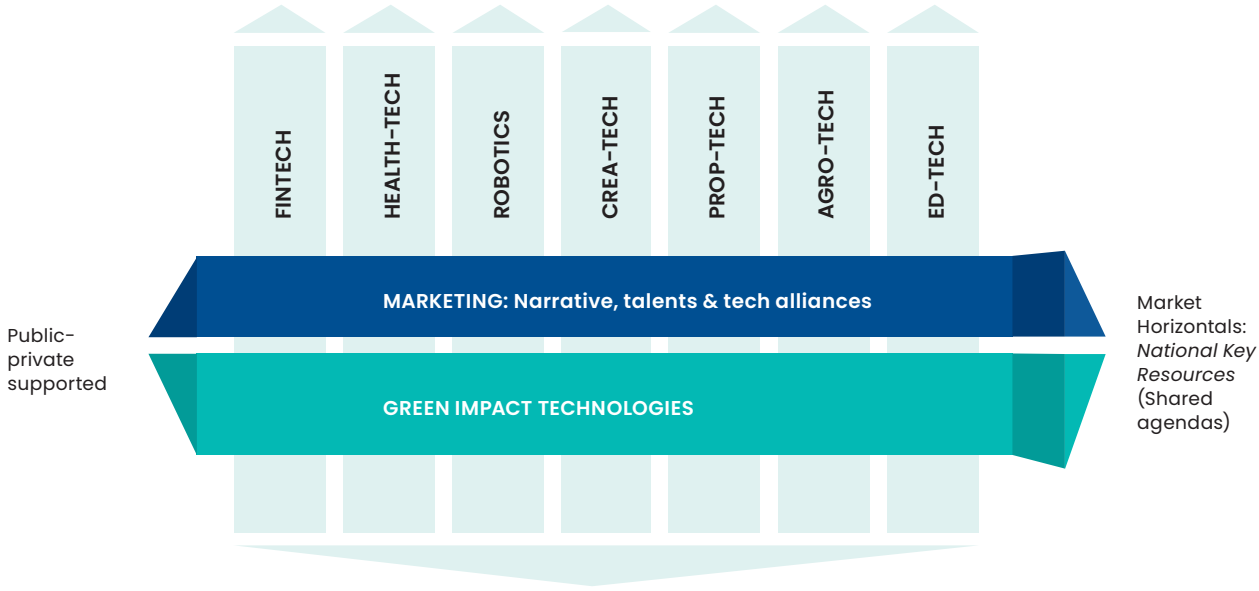


FIG. 2 *Digital ecosphere canvas exemplified by Digital Hub Denmark.*

tech-strongholds. The result became an overview of seven digital ecosystems identi ed by size, turnover and investments. Together these seven ecosystems form the Danish digital *tech-ecosphere*[3].

The mission to move Denmark to become an international frontrunner is to select, combine and cultivate national digital ecosystems where Denmark has a stronghold. This approach signi es a change from having various detached digital ecosystems based around main cities. For a small country like Denmark, this has been inef cient and cannot provide the necessary impact in a globally competitive world. Instead, establishing cross-regional digital ecosystems around speci c positions of strength, like ntech or agrotech, and supporting these by appointing national domain-speci c cluster organisations that can deliver focused marketing, attract talents and host visitor delegations, has proven to deliver results.

It also opens up new potential to drive innovation and growth, not only within the speci c ecosystems but across them, by supporting shared agendas that connect to larger societal transitions and megatrends. It is crucial to understand and advance such *market horizontals* because they add value across ecosystems and can therefore expand the digital transformative value proposition of the businesses within each ecosystem. This is exactly the case with green transformation, or more speci cally green impact technologies, which feature as a primary market horizontal across many ecosystems – and potentially all of them in the years to come.

[3] *Rosenstand, Claus: Selecting, combining, and cultivating digital ecosystems in a digital ecosphere.*

Key factors driving green impact technologies

The growing global recognition of the potential of green impact technologies is influenced by several factors. In the case of Denmark, there are specific drivers worth considering.

SENSE OF EMERGENCY TOWARDS GLOBAL CLIMATE CHALLENGES.

From the Paris Agreement to the UN Sustainable Development Goals and recently The European Green Deal, we can detect a growing concern, more committed national policies and the private sector pushing for change. The same goes for the UN's "build back better" framework, stressing the necessity to return to a post-pandemic world by harnessing green innovation.

ECONOMIC INCENTIVES AND POLICY INNOVATION.

Governments are getting on board and shifting tactics from soft rhetoric about the need for a green transition to clear incentives driven by tax legislation, binding green public procurement targets, and funding research and public-private innovation partnerships.

A TALENT CONVERGENCE BETWEEN THE TECH AND ENVIRONMENTAL IMPACT ARENAS.

Just a few years ago, these arenas seemed far apart but public research, higher education programmes, start-up incubators and a range of funding schemes that focus on the intersection between "tech" and "green" are now part of the picture.

THE GROWING INFLUENCE OF NEW GENERATIONS OF CONSUMERS, WORKERS AND INVESTORS.

Businesses are realising they may not have a viable business model, relevant products and competitive strength, if they do not shift their priorities and explore new vistas for green tech growth.

THE POSSIBILITIES OFFERED BY EMERGING TECHNOLOGIES.

New technologies are being harnessed to build new platforms and solutions that were simply unimaginable or too costly before their invention. Here the push of new digital technologies and the abundance of data opens our eyes to rethinking production methods, business models and consumer incentives in a more sustainable direction.

Danish Momentum

Denmark is continually ranked high as a country in which it is favourable to do business. In fact, in its most recent survey the World Bank ranks Denmark number 1 in Europe and number 4 in the world for ease of doing business[4]. In the context of green impact technologies and business solutions, there is a growing momentum, supported by a long series of critical initiatives that combine to make up a vibrant and supportive innovation community. These include start-up hubs, impact accelerator programmes, science parks, industry clusters, dedicated university research units and a range of specific public investment schemes dedicated to promoting and growing businesses that provide solutions to environmental challenges.

[4] *See https://www.doingbusiness.org/en/rankings*

According to Lise Walbom, CEO of Food Nation, a public-private partnership in the Danish food cluster, this momentum is indeed real, and is being seized by the business sector:

"According to our latest Insight Report on Denmark as a food nation, businesses play the greatest and most important role in driving sustainable development. And focusing on input factors is where they expect to create the largest positive impact. Like how we can use more recyclables in production and how to reduce environmental footprint and waste in the supply-chain. Or how to better make use of scarce raw materials including water and energy. So right now, there is a growing focus directed towards all the things that we are already very good at in Denmark. Things we are already doing. And that is why we are in a strong position."

In confronting a global climate crisis, the stakes are high, especially if it is to be done while maintaining our living standards and supporting developing countries to improve their economies. There is no silver bullet and, like other remarkable movements, green digital impact solutions are an important part of the greater solution-mix that is gaining quite a lot of attention and commitment. The green transition will only be achieved as a collaborative effort, which is also to say that the greentech movement must become an open invitation to participate, contribute and get on board.

According to our latest Insight Report on Denmark as a food nation, businesses play the greatest and most important role in driving sustainable development. And focusing on input factors is where they expect to create the largest positive impact.

– LISE WALBOM, CEO, FOOD NATION
(PR PHOTO)

Key initiatives supporting business innovation for green impact

CLUSTERS PLATFORMS

Formally interconnected networks of businesses suppliers, and associated institutions in a particular field are not peculiar to Denmark. What is interesting about the Danish approach is the triangulation of private enterprise, government institutions and academia. This is known as the triple-helix model of innovation, in which dedicated green companies, authorities, research and educational institutions are networking, innovating, and cooperating on the development and marketing of new products and concepts.

("Clusters driving greentech innovation"): Greentech Center, Danish Cleantech Hub, CLEAN, Copenhagen Solutions Lab, Gate 21, State of Green, Food Nation, Center Denmark and Food & Bio Cluster Denmark.

BUSINESS ACCELERATORS

New entrepreneurs need access to capital, dedicated mentoring and structural resources, like logistical and technical resources as well as shared office space, to prosper. Often accelerators also connect companies with peers from whom they can learn and well-established businesses with which to collaborate.

("Accelerators driving greentech innovation"): Accelerace, +Impact Accelerator, Nordic Impact Hub, Rainmaking Loft and the SDG Accelerator.

PUBLIC FUNDING SCHEMES

Public investment can be a powerful driver of large-scale economic transformations. Public investment can change incentives, reallocate resources in the market away from carbon-heavy production and invest where market actors might be hesitant. And they can bring start-ups to the next stage, where private funding steps in and powers scalability.

("Public funding schemes driving greentech innovation"): Denmark's Innovation Fund, The Danish Growth Fund and The Danish Green Investment Fund.

IMPACT INVESTORS

The trend is clear. The market for impact investing is growing in both depth and sophistication. In a recent study, 67% of investors said that they expected to increase their impact investments. And 83% of Nordic investors, investing in impact, expected their impact portfolio to deliver at or above the market rate of return[5].

("Impact investment initiatives driving greentech innovation"): Nordic Impact Investing Network, Plusimpact and Nordic Impact Hub.

[5] See *Impact report, Nordic Investors. Published by The One Initiative.*

FAUNAPHOTONICS PR PHOTO

Agro-robotics for sustainable farming

Leveraging new digital technologies to overcome old challenges.

COMPANY:
AgroIntelli

CO-FOUNDER & CEO:
Ole Green

SPECIALITY:
Agro-robotics and low impact farming

COMPANY:
FaunaPhotonics

CEO:
Michael Stanley Pedersen

SPECIALITY:
Agro-robotics and low impact farming

On a global scale we are currently trading enormous greenhouse gas emissions for food to feed the planet. Between clearing land to farm and the agriculture itself, that's around 20% of global emissions[1]. When other sustainability challenges, like depletion of soil nutrients loss of biodiversity and pollution, are added to this, agriculture is set to future-proof itself through a green transformation.

CALL FOR SUSTAINABILITY IN PRACTICE

Overall, the Danish food and agricultural sector is known for high quality and food safety standards, as well as animal welfare. In addition, as recent studies show, the Danish position of strength that international decision-makers rate highest is environmental sustainability[2].

This perception is con rmed by industry experts like Lise Walbom, CEO of Food Nation, a public-private partnership in the Danish food cluster, who declares that "we have a really good position internationally when it comes to sustainability"[3]. According to Walbom it is now imperative that Danish businesses begin to tell this story by explaining what they are actually doing and how they are working with sustainability in practice.

Recently this call for sustainability in practice has been taken up by a group of tech entrepreneurs and greentech start-ups who are applying the potential of new emerging technologies to secure both effective and sustainable agricultural outcomes.

"We are addressing a real problem, and we do it in a way where it creates great value. Both for the farmers and for society in general," says Michael Stanley Pedersen, CEO of FaunaPhotonics, a Danish company building next generation real-time insect monitoring technology to secure biodiversity in farming, while potentially saving costs on insecticides for spraying.

BRINGING ROBOTICS TO THE FIELD

Until recently most industrial robots in Danish farming were something you would come across if you entered the stables. Here they performed tasks like milking, mucking out and much of the physically demanding and hazardous work related to operating a full-scale farm.

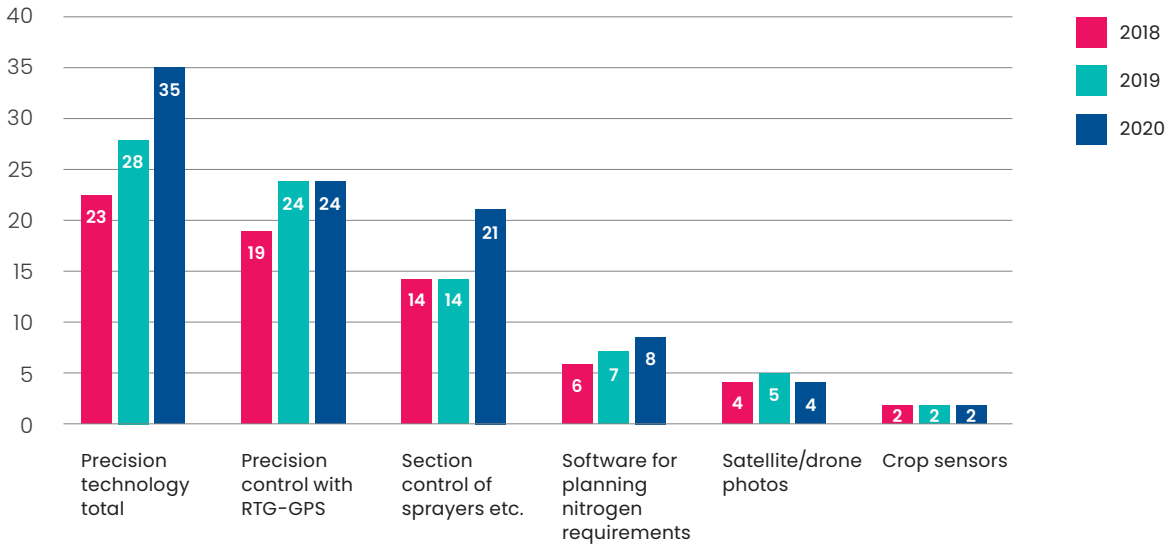
Today robots are increasingly being put to work in the eld, especially under what is termed *precision farming,* which involves using data from satellites, drones, image recognition technologies and self-driving robots to design less intrusive vehicle movement and fertilisation in the eld.

[1] *See http://www.environmentreports.com/how-does-agriculture-change/*

[2] *See https://foodnationdenmark.com/wp-content/uploads/Food_Nation_Insight_Report_2020_web.pdf*

[3] *Interview with Lise Walbom by Tænketanken Mandag Morgen and findings from the Insight Report on Denmark as a food nation 2020 developed by Food Nation.*

Precision Agriculture in Denmark



Source: Statistics Denmark, Præcisionslandbrug 2020.

Precision farming technologies are spreading across Denmark's fields. Research done by Statistics Denmark shows an increase in the percentage of farmers using precision technologies from 23% to 35% between 2018 and 2020. In addition, we see that 70% of all agricultural land in Denmark is cultivated by applying these techniques to secure low (negative) impact while maintaining high productivity.

Noteworthy is the trend of 24% of farmers using RTK-GPS[4] to plan for precise vehicle movement in the fields for tractors and combine harvesters. Also, we see 8% of farmers applying software to design a flexible, low-impact nitrogen supply into the soil. Another initiative, which is (4%), not yet widespread, is the use of satellite and drone photos to better monitor fields and protect biodiversity in the farmlands.

When we go deeper into the numbers behind this statistic, we can see that younger farmers (below 40 years of age) and bigger farms are faster to invest in and adopt new methods. However, the overall numbers indicate that a much broader group sees the value (if not the necessity) of making the shift towards low-impact precision farming.

PRODUCING MORE WITH LESS

In the case of Agrointelli, the company behind Robotti, a sensor-driven farming robot, the motivation to innovate is clear: "Through 20 years of research and development within sustainable soil management, I have seen the need for alternatives to the current heavy farm machinery," explains Ole Green, the company CEO.

The idea is based on the fact that farmers tend to treat

[4] Real-time kinematic (RTK) positioning is a satellite navigation technique used to enhance the precision of position data derived from satellite-based positioning systems (global navigation satellite systems, GNSS) such as GPS.

(= "Key to success"):

"Persistence. It is easy to give up. But to be – and this is perhaps not a Danish thing to say – very goal-focused, while insisting that you as an individual can make the world a better place, that is important."

– OLE GREEN, CEO, AGROINTELLI
(PR PHOTO)

all their soil and crops as if they are the same - without variation or change. In reality, the farmers' fields might vary quite a bit. However, if the farmer sows and fertilises evenly in the fields this can have a huge impact, not only on the yield but also on the environment. If some parts of the fields are sand and some clay, the plants' need for nutrients will vary. So, in effect, many tend to over-fertilise some parts of the field. The excess nitrogen can be lost as ammonia or nitrous oxide to the atmosphere or as nitrate runoff to nearby water environments, which potentially can contaminate groundwater or lead to increased algae production and oxygen depletion in lakes.

When there is data about the soil and machines to farm the soil precisely, this is easily avoided. In addition, when every plant gets just the right amount of nutrient it needs, the farmer is saving costs on fertilisers while also saving the environmental cost of the excess. In that sense, precision farming is a double-saving.

Robotti is a robot that can help manage the soil in the fields in a more sustainable way by minimising fertilisation and minimising the risk of soil compression and soil erosion that comes with the use of large tractors. "This is not just a Danish problem. It is not just European. It's a global problem," says Ole Green. The idea behind Robotti came to him when he was working with automatisation in plant production at Aarhus University in 2005. The idea was rather simple, he says. Instead of trying to optimise a tractor, he would optimise the tools, automatising the tools and making them self-driven.

Today, Robotti comes as an autonomous lightweight vehicle, equipped with GPS and sensor technology to calculate an optimised route in the field, while having a precision of 2 cm when performing tillage in the soil. There is also a further dimension to be aware of with this kind of innovation. It supplies farmers with a solution to a demand for labour that can be hard to satisfy, given that the work in the fields can be routine, physically

The sensor technology from FaunaPhotonics monitors insects and supports sustainable crop management.

FAUNAPHOTONICS PR PHOTO


WARNING IR emitted from this product.
Do not stare at operating lamp
IEC/EN 62471: RGI (low-Risk)
FaunaPhotonics

(= "Advice to pass on"):

"People who are looking to innovate the agricultural sector: Look at digitisation, be sure the solution you are building can be a part of this digital transformation of agriculture, and make sure you are creating real value for the farmers"

– MICHAEL STANLEY PEDERSEN, CEO, FAUNAPHOTONICS
(PR PHOTO)

exhausting and even sometimes hazardous. As Ole Green points out, agro-robotics can help create a safer and more engaging work environment for farmers and their employees.

In the end, he tells us, investors do not just invest in an idea, they also invest in people. "You need to believe in it. You need to convince them that it is you who will carry this through to the end. Even when it is hard" is the advice he would pass on to others wishing to build new greentech ventures.

MAKE SURE YOU ARE CREATING REAL VALUE FOR THE FARMERS

Another remarkable innovation in the eld is an insect sensor developed and brought to market by the Danish start-up FaunaPhotonics. Its technology platform combines information on insects, which is collected with a patent-protected sensor technique and machine-learning algorithms to differentiate among insect groups. In this way, the knowledge gaps can be lled that many farmers experience when they deal with understanding and securing insect biodiversity and how to control pest insects and insect borne diseases.

A concrete use-case is that farmers using the technology can see when bees are ying in the elds, and therefore reduce the level of spraying with pesticides. By using the data to alert them when an insect-pest is on its way, the farmer can see where and when it arrives, and therefore have a much better approach to targeting the use of insecticides. Overall, it helps farmers to be more precise and effective in their use of pesticides and decreases the risk of over-spraying the elds. The outcome is improved fauna and a lower possibility of resistance build-up within the insects.

Michael Stanley Pedersen, FaunaPhotonics CEO, points to the solution as being part of a broader movement harnessing the power of data collection and analysis to support better and smarter decision-making in agriculture. It is precision farming, and it is highly data driven. "This potential of getting a richness of information to make the right decisions. This is what we are doing," he explains, adding that "it is cloud solutions and machine learning and almost all the buzzwords you can come up with. But we are actually doing it."

As with many other tech companies, the early days were a real challenge. How do you take a complex and expensive laboratory set-up and make it practical and affordable? The solution was to develop the technology even further with the support of private investors. As Pedersen makes clear, the green agenda became a driving force at this stage, where the primary focus was on attracting capital and developing a commercially viable product.

Today, the company is planning to diversify from primarily applying their technology to rapeseed elds, to a range of other crops like wheat, white clover and beets. For now, its ambition is to grow its market in Denmark, without losing sight of international potential. In fact, just recently it collaborated with American tractor company John Deere to successfully test the possibilities of attaching the FaunaPhotonics sensors directly to the spray boom on a tractor.

Companies like Agrointelli and FaunaPhotonics are hardly lone stars, and we should expect to see a whole range of greentech entrepreneurs turn their attention to agriculture. As Mette Kramer, a consultant with SEGES, the leading agricultural knowledge and innovation centre in Denmark, puts it bluntly: "There has been talk of precision farming since the 1990s, but back then you just didn't have the technology for it."

For farmers, fighting climate change and protecting the environment essentially means protecting the future of their own livelihood.[5]

– URSULA VON DER LEYEN, PRESIDENT OF THE EU COMMISSION.

[5] *See https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_20_2457*

Waste management is data management

PHOTO: ZARKO IVETIC

Three Danish greentech start-ups show the way forward in how to tackle the problems of waste management and waste reduction using data.

COMPANY:
WasteHero

CEO & CO-FOUNDER:
Hussam Mansour

SPECIALITY:
sustainable and cost efficient waste management

WASTEHERO PR PHOTO

If all the garbage collectors went on strike one day, everyone would immediately recognise that waste management is a critical infrastructure in society. Our waste products would ll their designated containers beyond their capacity confronting us all directly with the hidden cost of consumption.

Besides the fact that the objects in the bin have life cycles of their own that generate carbon emissions, the processes that handle them, once you have thrown them out, are also resource-intensive, costly, and a source of carbon emissions.

In 2018, when the Danish municipality of Herning, population 89,000, was looking to further the sustainability of its urban environment, a key area was its handling of waste. The goal was to reduce its economic costs and its carbon emissions, as well as making the city greener and more liveable. Part of meeting this challenge was to integrate state-of-the-art technological solutions to the age-old problem of taking out the trash.

"There is no place in the world that you don't have to transport waste from, and every prognosis shows that there will only be more waste in the future," says Anders Hinrichs, Lead Product Engineer of WasteHero, the start-up that Herning municipality turned to for help with their waste handling.

WasteHero is a tech company based in Aarhus, specialising in technological solutions that optimise the infrastructure of waste management. They make use of the internet of things in the form of laser sensors coupled to data-handling back-ends and user-friendly interfaces for dynamically routing garbage trucks to empty waste containers as they reach capacity.

"There are a lot of heavy-duty CO2-emitting processes involved in the current way of managing waste. Garbage trucks are some of the most carbon-polluting machines. They drive slowly, starting and stopping all the time," says Hinrichs. "We want to move from static collection to dynamic, need-based collection, where you only gather waste when the emptying is effective. This is where you can really impact carbon emissions," he continues.

INSIGHT INTO GARBAGE CONTAINERS

Herning municipality manages its surrounding towns and rural area. As it developed its solution, Anders Hinrichs would go with the garbage truck drivers as they travelled far from the recycling centres and depots to empty the containers, in order to install the company's IoT-sensors.

"Sometimes, it takes 25 minutes to get to a giant underground container that is maybe 30% full. So, there is a great deal of wasted driving in this," he says.

WasteHero installed 150 sensors in waste containers around Herning, to measure when they were reaching capacity and needed emptying. By using data from these sensors, the municipality could reduce the scheduled emptying of the smart containers by half, reducing the costs related to those speci c containers by more than two-thirds. Armed with these insights, the municipality was able to engage with the further optimisation of the overall handling of waste from its 33,000 containers across the city.

The sensors that WasteHero uses to measure the storage load of waste containers works by shooting lasers into 16 points in the bin, forming a three-dimensional grid that makes it possible to calculate the volume of the garbage the bin contains.

"The rst wave of waste sensors used ultrasonics. They sent one wave down that caught what was closest. But because we are using laser sensors, we have the possibility of making 16 measurements and get a much more in-depth foundation for our calculation," says Hinrichs.

The sensors connect to cellular networks – legacy GSM, narrowband IoT and fourth generation LTE-M[1], as well as the lower band private networks seeing widespread use in smart cities projects.

But the data collected from the sensors is only one part of the WasteHero infrastructure. Its goal is to integrate all parts of the waste management process in Its system.

"We want to digitise every asset," says Hinrichs. "We can throw in all their containers, their vehicles, their drivers, their service employees, their route planners, all of those, and each of the individual stakeholders has a different interface, depending on their role in the waste stream."

Besides presenting waste data directly in their application interfaces, WasteHero uses it to train algorithms to make predictions of when to make effective collection, as well as optimising routing.

WasteHero is currently running pilot projects in 30 different countries and investors have con - dence in the viability of its solutions. In December 2020, the start-up secured 1.7 million dollars from Circles and Squares, Anorak Ventures, Momenta Ventures and one more undisclosed investor.

A plan where the plants save the planet

COMPANY:
PlantJammer

CEO:
Michael Haase

SPECIALITY:
Reducing food waste.

PLANTJAMMER PR PHOTO

Another Danish start-up uses technology to tackle the waste problem but from a different angle, before the waste hits the garbage bin and even before it hits your fridge as food.

PlantJammer was founded by Michael Haase, who had been working in commodities, consulting and intensive farming solutions when he decided to go 'fl xitarian', cutting down on meat in his diet while not going fully vegetarian or vegan. Having previously worked in areas where resource ef ciency was key, his reason for the dietary shift was sustainability.

Meat production is one of the key drivers of global warming, especially beef with its eighteenfold carbon footprint per gram of protein compared to grains, as shown by the largest meta-analysis of food system impact

[1] LTE-M is a type of low power wide area network (LPWAN) radio technology standard developed by 3GPP to enable a wide range of cellular devices and services (specifically, for machine-to-machine and Internet of Things applications).

studies to date. Even moderate reductions in meat consumption at the population level therefore has a marked impact on the future of the planet.

"One of the things that we have within the circle of control when it comes to sustainability is our eating habits and there are two components to that: one is, can we reduce our food waste? That is a big factor. And the other factor is, can we reduce our consumption?" says Haase.

His main challenge in adapting a predominantly plant-based diet, was cooking. When you are used to having meat at the centre of the meal, your cooking skills and repertoire of recipes also revolves around meat. He did nd some online resources for recipe ideas but craved a new way of exploring the potential of eating vegetables and decided to build a start-up around solving this problem.

"The fundamental premise is to make it delicious to eat sustainably," he says.

The solution, which also provided a novel way of reducing food waste, was to create a digital universe where a user can get algorithmic recommendations for recipes to cook.

"Our app helps people cook. That is the inspirational part but also the food waste part. You cook with what you have, which makes people better at emptying their fridges and using the ingredients they have in front of them instead of going grocery shopping," says Haase.

To accomplish this, PlantJammer has created an algorithm that predicts which ingredients go well together. This works in the same way as the predictive text suggestions on a smartphone, where an algorithm guesses the probability of the next word in a sentence. PlantJammer's algorithm predicts the next ingredient in a recipe, based on what other ingredients are available. The company trained the algorithm by using a training data set of more than three million recipes, gathered from all over the world wide web.

"Then we tag them with what language they are in and what gastronomy they are in, so the arti cial intelligence has some labels to use for knowing that now we are in Asia or now we're baking, so it learns more locally," says Haase

To make sure the app does not simply return statistical gibberish, as is the risk with machine learning algorithms, PlantJammer uses human common sense to make sure that the algorithmically generated recipes recommended to its users make sense, both in that they can be followed to create a meal and that the meal will have culinary value.

"We don't believe that the arti cial intelligence can come out of the black box and give you a complete recipe. The technology is not there right now. We use the arti cial intelligence for what it is good at and that's pattern recognition, like nding matches among ingredients. And then we use chefs and our own food scientists to create a language around it, which is where the users are guided," says Haase.

The app and recipe recommendation algorithm are only one part of the PlantJammer ecosystem. It also provides an API for other companies to make use of the algorithm. So far, supermarket chains in Sweden and Germany make use of the API access for making ingredient recommendations inside their own grocery apps. Additionally, small companies that produce sustainable foods use the recommendation engine to generate recipes for how to use their products.

"We make recipes for companies that take residual products from other industries and make food out of them. For example, Agrain, a Danish start-up that takes the mash from beer production, which normally is a residue that just gets thrown out. Instead they make our out of it and then they have to educate and inspire their consumers to create food with that our. It has different properties, so they need some guidance. That is where we use our technology to nd recipes," says Haase.

In July 2020, PlantJammer received a €4 million investment from Miele Ventures, Dr Oetker, and the Danish venture capital fund Vækstfonden.

The fundamental premise is to make it delicious to eat sustainably.

– MICHAEL HAASE, FOUNDER, PLANTJAMMER

Just say no to drug waste

COMPANY:
Drugstars

CEO & FOUNDER:
Claus Møldrup

SPECIALITY:
Healthtech solution supporting better drug-use and reducing drug waste.

DRUGSTARS PR PHOTO

Claus Møldrup used to be a professor of social pharmacy at the University of Copenhagen but he left his career in academic research, working with medical patients, to found DrugStars, a start-up designed to help patients take their medicines and optimise their treatment through behaviour change.

"I've always worked with patients in the pharmaceutical eld and when I quit to do this, it was to create better healthcare on the basis of the data residing with the individual patients," he says.

Users of the app enter the medications they use and are then reminded to take it at the right times. They also enter details about their use and the effects of the medication, information that DrugStars uses to assist patients towards optimal utility through behaviour modi cation.

"Helping patients get rid of their medicine was just a straight shot," says Møldrup. He describes the technology behind the app as "more common sense than machine learning".

"For example, if a patient answers that they forget to take their medicine, a reply could be to build good habits around taking the medicine around already existing habits. For example, place the medicine next to the coffee machine if you start with a morning coffee or the toothbrush at night, then you remember the medication more easily," he says.

DrugStars uses self-reported data from patients to build incentive structures for them. It gives out virtual "stars" for every action a patient takes around their medication, hence the name DrugStars. Whether for taking their medicine or for giving information about the effects, patients are rewarded with stars as a virtual currency that can only be used for a speci c type of transaction: donating to various patient associations, where the company exchanges it with real currency. Its revenue comes from selling the patients' data, anonymised and aggregated, to the pharma industry, while at the same time making it available freely to the patients themselves.

"We've done this for three years and have so far donated €450,000 to the 240 patient associations, that we work with," says Claus Møldrup.

DrugStars uses the same behavioural incentives to help patients get rid of their leftover medicines. When a patient hands in their medicine at the pharmacy, they can take a picture of the bag and get stars as a reward.

A small country like Denmark produces around 8,000 tons of waste medicine and medical packaging in a year, according to the Stop Waste Medicine Alliance, and that is only medications that are disposed of correctly. When you hand in leftover medications to the pharmacy they are treated as chemical waste and not ordinary household waste as it would be if it was thrown in the bin or, even worse, thrown in the toilet.

DrugStars has created its own campaign website to raise awareness of the correct handling of waste medicines: https://wastemedicinesmatter.com/

GOING GREEN ON INVESTMENTS

Impact investing means investing in companies, organisations and funds with the intention of making a social and environmental impact in addition to a financial return. In contrast to the classic view of profit maximisation as a business's sole purpose, impact investors believe that companies that aim to solve the pressing problems of today, often through innovative use of technology, can successfully combine a social conscience with profitable operations.[1]

Historically, Denmark has attracted investments due to a combination of factors, from innovative business solutions, to a highly skilled population, to the security and trust that comes from the welfare society and its foundational institutions.

Currently Denmark ranks 6 out of 49 high income economies for all-round innovation performance as per the latest Global Innovation Index[2], which highlights ICT infrastructure and skills as primary drivers in this area. These bene cial conditions for innovation are reinforced by the ease of doing business in Denmark.

In the yearly index by The World Bank, the top scorer amongst European countries is Denmark when comparing business regulations, and the extent to which these provide a positive arena for starting new business ventures. It is also worth noting that Denmark performs at the very top when it comes to trading across borders[3], which is crucial to creating widespread impact through green technologies.

However, while Denmark's overall performance in areas relevant to potential investors is continually strong, something new is also underway. In the landscape of investors, it seems that a rapidly growing group is making efforts towards going green on investments. A ourishing community of impact investors are gathering and making headwind, redirecting investments, and helping start-ups move beyond the feared "pilot-death" to become resilient businesses.

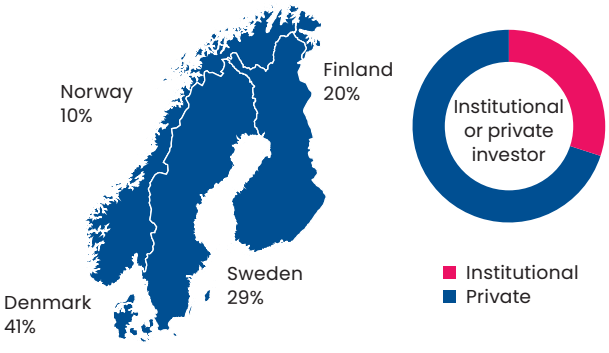
Initially a niche group of investors, today impact investments ow from a broad range of institutional as well as private actors. Dedicated platforms like The Nordic Impact Investing Network, The Nordic Impact Hub and +Impact (by Danske Bank) are de nitely making impact, focusing on start-ups within mainly cleantech, foodtech and biotech. From a different section of the playing eld, witness initiatives by Vækstfonden and Innovation Fund Denmark, which display dedicated green investment programmes that fund start-ups as well as SMVs. Beyond this, we have organisations like The Danish Green Investment Fund, which is a "green impact only" foundation supporting companies with innovative solutions to environmental challenges.

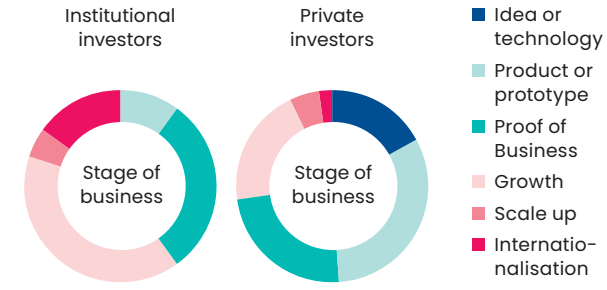
According to recent studies the impact investment community is growing rapidly in Denmark and the Nordics[4]. Today 41% of total impact investors are institutional actors, the highest in the Nordics, indicating that public-private funding schemes are popular in Denmark, although private funding still accounts for the majority of movement in this arena.

It is worth noting that early-stage funding for ideas or technology prototypes is almost exclusively funded by private actors. Only in the later stages do companies bring institutional impact investors on board to support scale-up and internationalisation.

The stage of investment is one thing; it is another to consider which companies and solutions attract the most investment. Here the high scorers are companies displaying innovative solutions within sustainable energy and energy ef ciency, industrial innovation and infrastructure, and responsible consumption.

All things considered, the impact investment community is greening the investment game, and it will be movement worth following closely now that old-school players like pension funds and banks are coming aboard.





[1] *https://s3-eu-west-1.amazonaws.com/katapult2018/Stateofimpact_web_single.pdf?mtime=20190118123740*

[2] *https://www.wipo.int/global_innovation_index/en/2020/*

[3] *https://www.doingbusiness.org/content/dam/doingBusiness/country/d/denmark/DNK.pdf*

[4] *See Impact report, Nordic Investors, published by The One Initiative.*

INVESTOR POINT OF VIEW

Anders Eldrup

WHO:
Anders Eldrup

Chairman, The Danish Green Investment Fund

Former CEO of Ørsted, Permanent Secretary at the Danish Ministry of Finance.

PHOTO: LISBETH HOLTEN

Anders Eldrup's views on the conditions and potential for investing in green technology solutions are in no way run of the mill. The former CEO of the global energy company Ørsted, which is routinely named the most environmentally sustainable company in the world, has the kind of oversight and rich understanding of the dynamics of the Danish welfare state to point out things that others overlook or downplay.

NOW IS THE TIME – A GLOBAL GEARSHIFT IS TAKING PLACE

"There is a de nite momentum for green investments right now", Anders Eldrup comments, explaining: "we are witnessing a more general shift of mindset towards climate consciousness". In Eldrup's view this was sparked by the Paris Agreement in 2015, when representatives from 196 states committed to directing their efforts to keeping the increase in global average temperature well below 2°C above pre-industrial levels, recognising that this would reduce the risks and negative impacts of climate change. According to Eldrup, a very clear indication of this 'gearshift' is the case of pension funds, which have become much more committed to redirecting their investments towards environmentally sustainable businesses and goals. Of course, he would know, given that he is also the chairman of the P+ pension fund, which has an entirely CO2-neutral portfolio and 135 billion Danish kroner to invest.

THE SECRET IS IN THE "CO" OF CO-FINANCING

Historically, the Nordic welfare states have been strong on public investment schemes, but for the last 10-15 years we have seen much of this substituted with public-private co- nancing programmes, which come in different forms.

In the case of the Danish Green Investment Fund, where Anders Eldrup is chairman, this is an independent state loan fund established as part of the policy agreement "A Greener Denmark" from 2014. The fund has a net capital of up to DKK 200 million, as well as a state-guaranteed lending limit of up to DKK 8 billion in capital to co- nance projects.

This model creates the perfect symbiosis between private and public investments.

– ANDERS ELDRUP

In short, the Danish Green Investment Fund seeks to bridge the gap between traditional bank nancing and equity capital. "We ll a hole in the investment landscape" as Eldrup points out. The individual loans provided by the fund are generally able to nance up to 60% of the total costs associated with the given project, which is very often taking on higher risk than banks are willing to do by themselves. But green entrepreneurs who have secured a loan from the fund, also use this as persuasion to bring bank investment into their business venture.

RECONSIDERING DANISH POSITIONS OF STRENGTH

When asked to consider the Danish positions of strength as an investment milieu for green impact there was no hesitation. We have built an open and informal workplace culture with "very little crude authority". In Eldrup's view this is worth highlighting and something that contributes to a start-up environment where exploring and testing solutions is crucial.

"Something we often tend to overlook is the positive role of workers unions" he states, and goes on to explain that many Danish unions are proactive and constructive when it comes to the automation of jobs and what some experts call *technological unemployment*. One example is the debate on robotics and "job destruction", where we have seen a commitment to focusing on job creation and how we can provide the workforce with the relevant competences and skills to master the new job functions that we expect will arise and be of value to society.

Lastly, Eldrup points to the level of education and skills in the general population, and of course the relative number of specialists and highly trained people in the workforce. This is not just a point about access to the strong skills of engineers or agronomists, but is also a broader message about the level of competence that eases the challenges of reskilling and upskilling non-specialists in the years to come.

THE GREATEST OPPORTUNITIES LIE BEFORE US

Looking towards the future to consider which sectors and technologies show great potential for business innovations and investors, there is the obvious case of wind energy, where Denmark has traditionally been a rst-mover. According to Anders Eldrup there still lies great potential in offshore wind energy to transition our energy systems, especially considering that the costs of offshore wind energy continues to drop. We see this re ected in the current decisions by the Danish government to install three large-scale offshore wind farms by 2030.

Another huge potential, and something that has until now been regarded as something of a moonshot, lies with the so-called power-to-x technologies. In short, these are technologies that convert surplus electric power and store them in the form of, for example, hydrogen or ammonia, so that they can be used by other sectors afterwards. This provides for a cross-systems improvement of energy ef ciency, and a reduction of negative climate impact – especially if based on renewable energy systems. In Denmark, as Eldrup explains, we are leading the way for business clusters and test sites to re ne and scale these solutions. "This is no longer speculative," he remarks, and we should be wise to follow this development closely.

INVESTOR POINT OF VIEW

Barbara Taudorf Andersen

WHO:
Barbara Taudorf Andersen

Professional Board Member, start-up investor and advisor with focus on Fintech and Greentech.

OTHER AFFILIATIONS:
Chair of the Board at greentech company Seasony.

BARBARA TAUDORF PR PHOTO

With superb knowledge of the Danish start-up and impact tech scene, board member and investor, Barbara Taudorf Andersen, can see both great potential and barriers in the mission to accelerate green impact technologies in the coming years.

COMING UP: DENMARK'S NEXT SUSTAINABLE ENERGY ADVENTURE

There is huge momentum in the move towards green impact technologies globally at the moment, Barbara Taudorf Andersen says, suggesting that "we need to build our next wind-energy adventure in Denmark". The problem is that when you look closer you notice that all the large investments are directed towards already existing technologies and solutions and the development of their distribution. In this area we are doing well, and the roll out of traditional wind-energy solutions has indeed been a success. But where should the next-stage technologies and solutions, come from when most of the capital is currently invested in tested and tried solutions? It is just as important, Taudorf Andersen explains, that we attract risk-prone capital and investors who are willing to develop the technologies of tomorrow for sustainable energy. This of course is a different kind of commitment, but it is crucial that "we are constantly thinking about developing the next level of impact ecosystems". For investors seeking that kind of engagement, interesting things are taking place in Denmark, particularly initiatives concerned with innovations around energy storage and for example power-to-X solutions, which are currently attracting a lot of attention.

LOOKING TO BE A PART OF POSITIVE IMPACT SOLUTIONS

Barbara Taudorf Andersen has a background in government, has worked with the Ministry of Finance and the Prime Minister's Office, and has held key positions in large Nordic banks. She was responsible for the national digital ID and payment schemes in Denmark and Norway. In recent years she has moved beyond the scope of the national financial infrastructure and fintech sector, and into the investor and start-up realm of green technology. "Basically, I'm interested in how we create an optimal and efficient society built on strong values like democracy, freedom and responsibility," she explains. "My personal quest is to bring all the experiences I have from working with the fintech sector and apply this to push greentech forward." On a broader societal level, Taudorf comments, "we are currently experiencing a series of urgent and necessary transformations in our societies, and of these the green transition needs to take precedence. "This will obviously demand political action, but in the view of Taudorf Andersen, that will not suffice and "the majority of action needs to be done from the marketplace". To accelerate this process, we will need a two-sided engine, one side powering a green transition of the major established businesses, while the other drives growth in the impact start-up ecosystem, providing the former with new technology, and also developing the business models of tomorrow. This two-pronged development is about creating the right conditions for a large-scale transition, and for

Fundamentally,
I'm looking for solutions that create
a widespread impact.

– BARBARA TAUDORF ANDERSEN

Taudorf Andersen personally, it's about contributing to building the climate technologies that can lead to this kind of impact. One area she is particularly preoccupied with is sustainable farming, more speci cally *vertical farming*, where she contributes as an advisor to and investor in start-ups, and also holds the position of chair of the board at Seasony, a Danish company specialising in robotics for vertical farming.

CONSIDERING DANISH POSITIONS OF STRENGTH

Historically, the Nordic welfare states have invested heavily towards building a strong and convenient public digital infrastructure and developing digital skills in the population. In addition, in Denmark we come from a tradition of focusing on environmental and social sustainability, which means there are advanced competences in these elds to add to the overall credibility we have in this area. These kinds of foundational initiatives and histories combine to create a much broader foundation from which we are currently seeing new innovations and business ventures.

According to Taudorf Andersen, when considering speci c Danish positions of strength for green impact technologies, it makes sense to distinguish between sectors and capabilities.

Our sector-related strongholds are re ected in the start-ups, innovations and investments being made in the food, agriculture and energy sector. So many interesting things are taking place, whether it is about alternative protein production, low impact or vertical farming, energy storage or even next generation nuclear reactors, all these areas put Denmark on the map amongst the frontrunners. But there is more.

In the view of Taudorf, we must also recognise the key capabilities, that contribute to Denmark's potential. In addition to an advanced digital government comes a superior and world-class eld of robotics, for example those nurtured through regional clusters, like Odense Robotics. We have the ability to integrate these technologies into a wide range of elds, thereby becoming a cross-sectoral value creator. For example, in sustainable and vertical farming, companies like Seasony enable automation, data gathering and surveillance with an intelligent mobile robot. So, we have this ability to take these advanced solutions, like robotic solutions, and apply them to other elds, and towards many different challenges, and this is a clear strength.

We often tend to overlook the positive role of partnerships and alternative business models, as it's the tech that gets most of the attention. But in the eyes of Taudorf Andersen, this is unfounded, and we should expect that in the coming years innovation will not necessarily be driven only by new technologies. It will come from creating partnerships and building businesses in new ways. We will see this where the disruption of sectors takes place, because the entire value-chain is being disrupted, where distribution nodes are removed, leading to less transport, fewer cost links, and potentially reduced waste.

In energy and food, the climate challenge that we are all facing is the main driver for disruption. However, according to Taudorf Andersen, we will succeed only where we can produce and distribute ef ciently at a strong price point - and deliver products and services that are just as good or superior to conventional foods.

NO COUNTRY IS AN ISLAND: WE NEED INTERNATIONAL COLLABORATIONS

One area where Denmark can de nitely improve lies in our ability to commercialise science and research in a large and rapidly scalable format. This is something, that, according to Andersen, we can learn from international collaborators, because until now we have not seen many investment funds dedicated to speci c areas and societal challenges. In this sense looking towards international collaborators means engaging with specialised investment funds that can provide a combination of capital and competences within a speci c area, and in this context, of course, relating to the eld of green solutions and impact tech. "If we begin to do this, we can begin to scale Danish companies much faster," says Taudorf Andersen.

Building a platform for green finance

MATTER PR PHOTO

These Danish start-ups are building the infrastructures and interfaces to make sustainable nancial investments accessible at scale.

Niels Fibæk-Jensen and Alexander Harrington, CTO at Matter, in their upcoming office location in Copenhagen.

PHOTO: ARTHUR J. CAMMELBEECK

COMPANY:
Matter

CEO & CO-FOUNDER:
Niels Fibæk-Jensen

SPECIALITY:
Sustainable company pension

The Danish business community has long been at the forefront of the environmental agenda in general and the agenda of climate change in particular, especially in the energy sector, and the ICT sector is not far behind. In Copenhagen, ntech entrepreneurs are innovating in a race against time to bring sustainable investment opportunities to market.

In the wake of the United Nations ratifying Agenda 2030, with its 17 Sustainable Development Goals and their associated 169 targets and 232 indicators, and the almost global rati cation of the Paris Agreement, as well as the increasingly apparent immediate effects of climate change on the planet, nancial markets are beginning to feel the pressure for sustainable investments.

Building technologies to offer the opportunity to easily invest ethically and sustainably for both individuals and rms is the growth potential in the business models pursued by three Danish ntech start-ups.

INVESTING IN A SUSTAINABLE FUTURE BEYOND RETIREMENT

CEO of Danish ntech start-up Matter, Niels Fibæk-Jensen used to work at the UN in New York City, furthering the sustainable agenda through nance from a policy perspective. What he identi ed there and what he set out to solve with Matter was a massive global challenge when it comes to sustainable investment.

"If we are to solve both the climatical and societal challenges that confront us, then we have a gigantic nancing gap. We are about US $2,500 billion a year short if we are to achieve the UN Sustainable Development Goals," says Fibæk-Jensen.

For most Danish wage-earners, nancial investments happen through their pensions. Matter was founded on the premise that pension funds could have a heavy-duty impact on investment markets if they began using their capacity following an ethical investment strategy. When Matter started out in 2017, they launched the rst two sustainable pension schemes in Denmark in collaboration with rst Skandia and later AP Pension. Since then, most if not all Danish pension funds have marketed their own sustainable scheme, while several have also begun divesting themselves from fossil fuel companies. In the meantime, Matter has also pivoted away from being a pension provider.

"As often happens with start-ups, we found out that

what we were good at was not necessarily pension advice, it was to a higher degree helping investors understand where they were positioned with regards to sustainability and what they could improve, if they wished to, and how to report it to customers in a reasonable way. So during the last year, we started working with other investors helping them understand the degree of sustainability of their portfolios and reporting it to customers with the help of digital solutions," says Fibæk-Jensen.

The basis of their business has not changed, however they provide an in depth understanding of the many sustainability indicators relevant not only to investors but also to the wider society.

"Our foundation of knowledge, what we counted on based on our experience launching our own pension product, was that we had to make sure that our understanding of sustainability dovetailed with the understanding that the world around us had. So we set out collecting data from a wide variety of NGOs, think tanks, research institutes, and pioneers in sustainability, both nancial and non- nancial, a lot of alternative data as it's called in business jargon, and built it into a database of thousands of companies to nd out how sustainable they actually are in the eyes of experts. Not only what they self-report, but also what the world around them thinks," says Fibæk-Jensen.

This highly curated dataset is at the heart of Matter's business model and they wrangle it into a variety of services relevant to their customers, investors moving towards building more sustainable portfolios. This has allowed them to move from a sharp focus on pensions to becoming a highly data-driven sustainable business intelligence start-up.

"We slowly started automating this solution and making it available for customers as automated reports. The technology behind it is rst about collecting data from these hundreds of trusted expert sources and then thousands of media sources where we use natural language processing to analyse and understand sentiments of whether companies are being praised or criticised on sustainability criteria. From there we are able to match it to a customer's portfolio using named entity recognition to be able to analyse how sustainable the customer's positions are," Fibæk-Jensen explains.

They take a modular approach to building their services, in which each technical element is designed as a

COMPANY:
Doland

CEO & FOUNDER:
Jakob Lage Hansen

SPECIALITY:
Personal green investments

DOLAND PR PHOTO

COMPANY:
MakeImpact

CEO & FOUNDER:
Varan Pathmanathan.

SPECIALITY:
Accelerating purpose-driven investments.

PHOTO: CLAUS SALL

microservice that is potentially useful outside of Matter's own business goals.

"When we build this, we do it in a way where we can make sure that we can sell it to others. Of course, we build for our own operations, but we also have to build solutions that are relevant for others someday," says Fibæk-Jensen.

In December 2020, Nasdaq Ventures made a strategic investment in Matter, with undisclosed terms, for the purpose of shoring up Nasdaq's own ethical, sustainable and governance solution already powered by Matter's technology.

MAKING SUSTAINABLE INVESTMENTS ACCESSIBLE TO THE MASSES

One company that makes use of Matter's modular microservices is DoLand, a personal investment start-up in closed beta with a few thousand users at the time of writing.

Investment for most people is an esoteric practice. DoLand wants to democratise it, making investing more broadly available outside of traditional investor circles and in a sustainable fashion.

"Investment in the traditional model is quite undemocratic. The individual is not heard when it comes to where their money is being channelled and thus what kind of society they are part of building with their savings. What we wanted to facilitate at the basic level was that as an individual you could make known what type of companies you would like to place your money in and thereby which parts of society you are pushing forward," says Jakob Lage Hansen, DoLand's CEO.

As a DoLand user, you state your preferences for different sustainability themes and indicate your economic situation. The company then uses automated advice to match investments that t your interests and budget. The front-end of the service gives users a dashboard where they can follow both the nancials of their investments and their sustainability impacts. This is where DoLand hooks into Matter's screening tools. On the back end, they collaborate with Saxo Bank to execute the actual investment. But DoLand is responsible for the investment advice they give their customers.

"We do quality control and due diligence ourselves. We evaluate the products that we advise our clients to invest in closely to make sure that they are sound investments with the right nancials and impact. Matter's tool helps report the impact to customers, but it is our own evaluation. We are licensed investment advisors in Denmark. The core of what we do is to educate and create the knowledge and con dence needed, advise customers on how their investment should be composed, and report to our customers how the investments perform. We tap into a lot of different partnerships to make it all function. Our approach is very partnership-focused. We create the core ourselves and tap into the knowledge, solutions and competencies that are available other places instead of reinventing the wheel. We make it all come together and have the nal accountability to the customer on the overall composition of their investment and also the continuous follow-up," says Hansen.

DOING-IT-YOURSELF SUSTAINABLE INVESTMENTS

A different way of making nancial investing more broadly available through technology is being pursued by the Copenhagen-based start-up MakeImpact, whose goal is to get rst time investors on board. One challenge here is to make it clear to rst-time investors how investment actually works; another challenge is to make them understand how to invest sustainably. The solution MakeImpact provides relies on techniques of persuasion.

"We use persuasive technology, behaviour-modifying technologies, to get users to change behaviour based on their own individual values. We use those technologies to create awareness but also to move our users on to this journey. We look at the user journey and the challenge young people generally have with getting started investing, and in particular with investing sustainably, getting an overview of numbers that are incredibly foreign for people who have never invested before," says MakeImpact CEO Varan Pathmanathan.

The UN Global Compact is a non-binding United Nations pact to encourage businesses worldwide to adopt sustainable and socially responsible policies, and to report on their implementation. The UN Global Compact is a principle-based framework for businesses, stating ten principles in the areas of human rights, labour rights, the environment and anti-corruption.

Rather than calling it a ntech start-up, Varan Pathmanathan describes MakeImpact as a "content and community platform". The app will let the user pick at least three sustainability values on which to base their investments. These values are based on the 17 UN Sustainable Development Goals. MakeImpact then matches the user's choice with publicly listed companies that report on the same goals.

"The UN Global Compact is the holy grail of data that we look at right now. Eight thousand companies have signed up and report yearly on their work on the Global Goals and commitment to support a sustainable agenda. That is the data we take as our starting point. Of those, around 1,500 are publicly traded. Then we nd other sources on those for the users. At no point do we advise a customer what to invest in. It is very important for our DNA in MakeImpact that we do not want to act as sustainability experts in this eld. We want to make knowledge accessible in a digestible way. But it is up to you who to invest in," says Pathmanathan.

The information collected by the UN Global Compact is based on self-reported data from the companies. MakeImpact insists that they are not giving nancial advice but making information freely available. When a user makes an investment through MakeImpact, it is handled with an app-switch to an investment partner app. Currently, MakeImpact's investment partner is Nordnet.

"So, the money transfer happens in the investment platform we collaborate with. Business model-wise there is some lead acquisition in that part, so the partnerships are driving some of it. Then you can track your portfolio's sustainability in our app through the Swedish company Tink, so no matter where your portfolio is, we can visualise how it looks from the perspective of a Sustainable Development Goal," says Pathmanathan

PHOTO: ZARKO IVETIC

From unusable bricks to unusual buildings

Danish architecture rm Lendager is developing an automated solution to upcycle brick sections that would otherwise be downcycled into land lls.

Anders Lendager, CEO and founder of Danish architecture firm specializing in circular economy.

PHOTO: ZARKO IVETIC

COMPANY:
Lendager Group

CEO & FOUNDER:
Anders Lendager

SPECIALITY:
Circular Economy in buildings and architecture.

Besides being unusual buildings for nice city living, the Resource Rows, "Ressourcerækkerne" in Danish, situated in Copenhagen's Ørestad district, have a very special story. In collaboration with Carlsberg, Lendager Group has cut out brick modules from Carlsberg's historic breweries in Copenhagen, so that the history and soul of the old buildings is now continued in the Resource Rows. Other bricks in the project come from old schools and industrial buildings around Denmark.

In the Resource Rows, the architects have also used recycled wood waste from the construction of Copenhagen Metro for facades and interiors. The whole project was drafted by Lendager Group, a construction group that also supplied the upcycled materials for the buildings.

The project consists of 29 row houses and 63 apartments. Their most salient external features are the one-by-one-metre sections of masonry, forming a patchwork across their facades. These squares consist of both horizontal and vertical brick patterns.

"The Resource Rows is one of the world's rst circular economic buildings realised commercially," says Anders Lendager, the construction group's CEO and architect MAA.

Lendager Group has made a name for itself as being in the vanguard in applying sustainability and circular economic principles to architecture in practice.

"We have succeeded with that because we insist that it has to be cost-neutral. We consider economics as a very, very important, if not the most essential, component. We have to make sustainability and economics compatible and not contradictions," says Lendager.

Based on their experiences harvesting the sections of masonry for the Resource Rows, Lendager Group is now developing an automated solution for cutting out brickwork from decommissioned buildings.

"What if you could create a robot that could go in and cut up these buildings, that could 3D-scan them, plan to cut them down into those components that we have already drafted digitally into 3D-models in Revit, and turn a selective demolition into production by a robot? That is what we have begun developing with the robotics department at the Danish Technical University, creating a mechanism for optimising reuse as an extremely high-tech solution to something incredibly low tech, that is, to cut up a building," says Lendager.

TURNING OLD HOUSES INTO NEW BRICKS

According to the United Nations Environment Programme's *2019 Global Status Report for Buildings and Construction*, the construction sector was responsible for 36% of global energy use and 39% of global energy-related CO2 emissions in 2018, or 23% of global emissions in total. Out of those emissions, 11% were just from the manufacturing of building materials. And these numbers had grown by 1% and 2% respectively since the year before.

These growing numbers represent what is referred to as "embodied carbon", meaning greenhouse emissions resulting from the production of the materials for and construction of buildings.

At the opposite end of a building's life cycle is the demolition process, where the amount of embodied carbon increases further as building materials are turned into waste. And the amount of construction waste produced in the world is staggering.

According to the Danish Environmental Protection Agency, construction waste is the single largest proportion of waste in Denmark, amounting to one-third of the total waste production measured by weight. Similarly, according to the Agency, the construction sector uses one-third of the world's resources globally.

From a circular economy perspective, this is an opportunity for resource innovation, treating demolition as a form of production, shifting the paradigm of how construction waste is conceptualised and managed.

"The big demolishers invest in nding out what their role is in not destroying and demolishing things, reducing their value, but creating value every time you take something down," says Lendager.

However, even as the paradigm shifts, the construction industry confronts half a century of technical debt

literally built into the structure of the houses scheduled for demolition, because since the middle of 20th century, brick houses have not been the same.

THE BRICK-AND-MORTAR BUSINESS

If you look at Danish brick houses built before the 1960s, the settling cracks that develop in the walls as the ground slowly moves under them tend to run along the mortar, whereas newer houses tend to crack through the bricks themselves. The reason for this is a major technology change that took place in masonry at the time: the switch from lime mortar to cement mortar.

Lime mortar is more elastic, porous and breathable than cement mortar, which on the other hand is stronger and more durable. Cement mortar also hardens faster, which provided an immediate ef ciency bene t in the construction industry as masons could work faster. In Denmark, this technological change happened across the masonry profession in the 1960s.

This means that in modern brick houses built after the 1960s the mortar is the strongest element of the wall compared to the brick. And this has implications for the possibility of reusing building materials from demolished houses in new construction projects.

In fact, while recycled bricks can fetch a good price and are considered valuable raw materials for new buildings, it is close to impossible to clear off the mortar and reuse the bricks from houses built later than 1960 cost effectively because of the strength of the cement mortar. Currently, there is no way to remove cement mortar from bricks without damaging them. This means that valuable materials from demolished buildings are being downcycled into road lls or land lls.

"That made us say, hey, that is something we need to nd a solution for. And the solution was that we considered these existing buildings as a big piece of mass that you could cut big slices out of. And if you could cut big slices out of an old building, then you could move them and build with them," says Lendager.

Although the estimates vary, a recent study from The Danish Center for Social Science Research (VIVE) esti-

According to the United Nations 2018 Revision of World Urbaniation Prospects, four billion people, or 55% of the world's population, live in cities. This mass migration is recent, having taken place over the last 200 years, with more than half of the world's populations living in cities only since 2007. The UN estimates that two-thirds of the global population will live in urban areas by 2050.

Why is it that when you bring your dogs and cats, ugly vases and furniture, and children with you to your new home in the city, why don't you bring the building materials, when you have them available, instead of digging up virgin materials from mines?

– ANDERS LENDAGER, CEO, LENDAGER GROUP

mates that roughly 10-20,000 houses in Denmark, many in peripheral areas, are empty and ready for demolition.

"We asked ourselves the question: Why is it that when you bring your dogs and cats, ugly vases and furniture, and children with you to your new home in the city, why don't you bring the building materials, when you have them available, instead of digging up virgin materials from mines? And that idea was re ned by the fact that brick is one of the most expensive building materials we have, seen as a single object and in relation to its size," says Lendager.

SMALL STEPS FROM MANUAL TO AUTOMATIC DECONSTRUCTION

Upcycling otherwise unusable construction waste is a problem that Lendager Group has showed is solvable, as demonstrated in the facades of the Resource Rows. Scaling this solution is what the architects are now attempting to achieve by turning to automation.

"I had a vision together with Anders that you could build a robot that would scan a schematic and then scan the building and, seeing if the schematic and building are consistent with each other, calculate how to get the most square meters out of it. That is one way to build the machine. The other way is that you have an architectural project with some wishes, and you ask, how do I get elements cut out that matches those wishes and how much will it yield? And then it should just drive up to the facade and start picking. That is where we want to go, but it is not going to be as robotic in version 2.0," says Niklas Nolsøe, Head of R&D at Lendager Group and architect MAA.

Besides the practical challenge of cutting out speci c sections of wall with a big diamond saw, the core problem that Lendager attempts to solve by automating is making it cost effective to produce the brick sections from the walls of decommissioned buildings. In this, the most expensive part is currently the person-hours involved in having two people manually cut out each section of wall, the practicalities of which Lendager Group learned from producing the individual sections for facades of the Resource Rows.

"We sat with building schematics and got an idea how much brickwork we could cut out. And we had a very manual process with a platform that went up and down and developed a cutting assemblage that was basically a square frame that you could run a diamond cutter through," says Nolsøe

Building a robot to cut old buildings into brick sections that are usable for new construction is the end goal, but Lendager Group is taking the innovation process one step at a time. The next step is automating parts of the manual process.

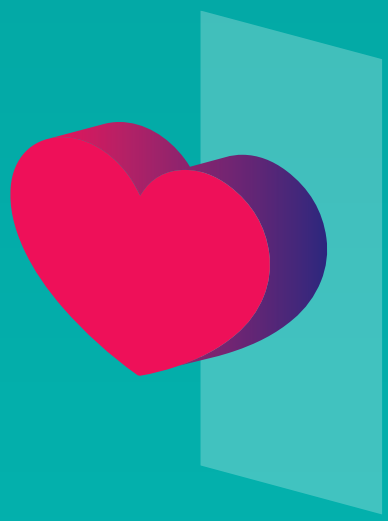
"Version 2.0 is the same as version 1.0 but streamlined and optimised. We are not all the way where we have a robot arm that can do it itself, with someone standing on the ground with a remote control. But that is where we are going," says Nolsøe.

Part of the reasoning behind this step-by-step approach is the sheer cost of physical process automation. Building a fully autonomous robot involves a lot of economic risk, and Lendager Group is committed to cost-neutral sustainable architectural solutions.

"I would call it semi-automation here in version 2.0, and version 3.0 can be a more automated solution, and then we have to see how far we can go and how expensive it becomes. In the end it all hinges on the brick sections dropping so much in price that it becomes worthwhile to build it back into a construction again," says Nolsøe.

Lendager Group is developing the automated solution for harvesting sections of brick and concrete wall in collaboration with IPU and Tscherning with support from the Danish Environmental Protection Agency's development and demonstration programme.

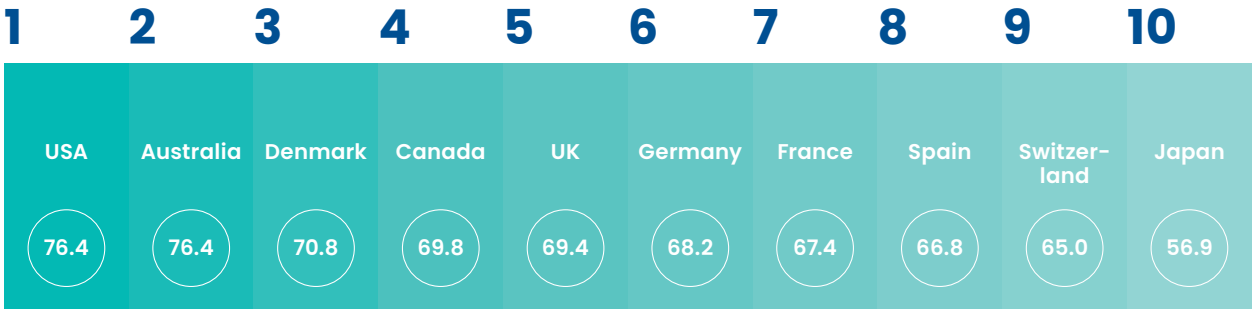
FINDING PURPOSE AND PERSONAL IMPACT



What really attracts greentech talents to a career in Denmark.

Global Digital Talent Work Happiness Index

How happy are you with the following elements of your current job? (100 = very happy)



Note: The work happiness score is computed as a simple average of 17 job elements. 0 is very unhappy, 25 is rather unhappy, 50 is neutral, 75 is rather happy and 100 is very happy.
Survey performed by Boston Consulting Group/Dynata proprietary survey and analysis for Digital Hub Denmark

According to the Digital Talent Global Work Happiness Index, digital talents experience the highest levels of work happiness in the USA, Australia and Denmark, while Denmark is placed at the top for digital expats[1].

Looking deeper into the study we nd digital talents indicating the crucial importance of work-life balance, an organisational purpose, potential for personal impact, and a creative and innovative work environment as some of the main reasons for enjoying their work-life. Amongst these top components of job satisfaction, *my organisation's purpose* and *personal impact* are unique to Denmark.

Further research suggests that digital talents in Denmark score their organisation's purpose so highly because their solutions are often highly valued when implemented in public and private organisations. Summing up; it is highly satisfying to experience your work being put to good use. When it comes to personal impact, many associate this with their individual contribution to the nal product. Here, being a part of an informal work hierarchy in the workplace, taking on more responsibility and better understanding the task at hand, all play a considerable role and add to their happiness with personal impact.

Other bene ts that most often come with a job on the Danish tech scene include ample paid vacation, parental leave, health insurance and pension savings. Interestingly there are differences between younger and older tech employees. Young talents (under 40) emphasise that the social environment and learning and career development opportunities, and not least, *my organisation's environmental efforts,* are of great importance, and affect their search for job opportunities.

For businesses developing green impact technologies this opens up the potential to make this a clear and prominent part of their value proposition to potential employees. And, as we will see in the following portraits of two greentech talents, it is already a primary driver and motivation for people in the early stages of their careers in Denmark.

[1] *https://digitalhubdenmark.dk/media/8d89d19d8256dab/201001_global-work-happiness-survey_bcg_vf.pdf*

Working in Denmark as an American expat: "It has been really, really rewarding"

Switching industries and continents to make an impact.

Charlotte Searle is a senior data analyst at Too Good To Go, a Danish company that strives to reduce food waste globally through the Too Good To Go app, which enables its users to purchase surplus food and groceries from local businesses. Upon securing the job at the Danish company, Charlotte Searle, born and raised in America, moved to Denmark to start her new position.

Searle has a BSc in mathematics and an MSc in business analytics from the University of Virginia. During her undergraduate programme, she discovered the eld of data science. This new-found interest led her to begin to broaden her theoretical knowledge of mathematics to a more applied level, aiming to bridge people's understanding of how they can use technologies.

Having started her career working with data analytics and data science at a digital marketing rm, the rst lockdown of the COVID-19 outbreak in 2020 made her reconsider her career path. She had always wanted her work to be centred around people – work that energised her. But more importantly, she started to rethink where she would be able to make the greatest impact through her work:

"I have always been motivated by impact, and I was really interested in greentech and sustainability. I was driven by an aim of going all in on understanding how I could apply my skillset in data science and analytics to the greentech movement. I felt a really strong connection to the mission of Too Good To Go and thought it was aligned with my personal career interests."

Switching industries from business analytics to greentech in the pursuit of increasing her impact on the world

PHOTO: ZARKO IVETIC

led her across the Atlantic Ocean to a small speck on the map: Denmark.

ADJUSTING TO A NEW WORK-LIFE BALANCE

Expecting her co-workers to be in full activity, Searle showed up at work on her first morning at 8:30, only to find an empty office. At her former workplace in the U.S., there would have been many activities going on at that time of the morning. To Searle, this was the first sign that she was in a completely different working environment to the one she was used to:

"There is very much this emphasis on not working too late and not feeling too much pressure to get things done tomorrow no matter the cost."

Denmark is well-known for its favourable work-life balance, which is one of the components of the working environment according to a recent report published by Boston Consulting Group[2]. In the OECD Better Life Index, Denmark is placed third among OECD countries when it comes to work-life balance[3]. The prospect of this different approach to work-life balance initially worried Searle. She thought it might translate to people not being engaged in their work – a concern that clashed with her decision to move across the globe to work for a mission she deeply cared about. However, these worries were quickly put to rest:

"People take work very seriously in my office, but it does not translate into needing to spend all of your hours of the day [at work], which I think is actually very good for your productivity and effectiveness overall. That was part of why I wanted to come, too."

A SMALL COUNTRY WITH A BIG IMPACT ON THE WORLD

Being driven by the desire to make an impact through her work, Searle does not hesitate to recognise the influence of the Danish greentech industry worldwide:

"There is a lot happening in Denmark that is getting attention elsewhere. Denmark is small, but the ambitions are high and there is a lot of impact happening on a much grander scale from what is happening in the greentech space here. That is true for Too Good To Go, but it is also true for many other companies."

Despite having only been employed in the greentech industry for a few months, Searle already sees a lot of potential within the industry, as well as a future for herself working in greentech:

"There is so much variety in the types of solutions in greentech. In my mind, there is no chance of being bored in this industry. And [...] it is something I care deeply about. I don't really see any reason why I would switch to another industry at this point."

NOT BEING AFRAID TO TAKE A LEAP OF FAITH

Searle points to two key lessons when asked what advice she would give others in her position. First, she finds it important to know what your career ambitions are. Understanding her own career goals led her to switching industries and continents. Second, Searle emphasises the importance of not being afraid to reach out to people to make your ambitions come to life:

"Tap into the communities that exist around whatever it is that you are interested in. I spent a lot of time joining different Slack networks and just reaching out to people. [...] If I had not sent that one LinkedIn message to my new boss ... If I had felt a little bit of fear in that moment and not gotten the guts to do it, then I would not have gotten this great opportunity."

There is very much this emphasis on not working too late and not feeling too much pressure to get things done tomorrow no matter the cost.

– CHARLOTTE SEARLE, SENIOR DATA ANALYST, TOO GOOD TO GO

[2] *Report by Boston Consulting Group in collaboration with Digital Hub Denmark: https://digitalhubdenmark.dk/media/8d89d19d8256dab/201001_global-work-happiness-survey_bcg_vf.pdf*

[3] *http://www.oecdbetterlifeindex.org/topics/work-life-balance/*

Co-founder of Danish greentech start-up: "Being a greentech start-up in Denmark has never been more attractive"

The aim in Reel is to be the next success story to grow out of a pioneer spirit.

Jon Sigvert is the co-founder of the Danish start-up, Reel, which seeks to innovate corporate power purchase agreements (PPAs) between corporations and energy producers. Aiming to reduce the energy sector's environmental footprint, Reel is currently working to standardise the legal frameworks of PPAs and to build a technology that pools small- and medium-sized businesses in clusters that imitate large corporations, thereby allowing them to enter PPAs on an equal footing with large corporations. Through this rethinking of energy agreements, Reel's goal is to further encourage energy producers to establish green energy solutions such as windmill parks:

"I am a big climate and environment advocate. I aim to be a realist and have a constructive approach to the climate challenges. If we are to solve the climate challenges in time, we need to develop new and innovative solutions."

Having always been keen to improve the transition to renewable energy solutions, Sigvert is now using technology to help this transition along. Through Reel, Sigvert is motivated to make his contribution to Denmark's path towards becoming a carbon neutral country by 2050:

"Denmark has been a pioneering country in sustainable solutions. Our aim in Reel is to be the next success story to grow out of a pioneer spirit."

MAKING THE MOST OF UNIVERSITY PROGRAMMES

A recent MSc graduate from the Technical University of Denmark (DTU), Jon Sigvert studied environmental engineering with a specialisation in sustainability assessments and life cycle analyses. DTU is also the place where Sigvert and his co-founder took the first step toward taking Reel from idea to reality.

Through an entrepreneurship course at DTU, Sigvert launched his start-up with the support of DTU Skylab, DTU's hub for innovation and entrepreneurship. Reel landed a spot in the DTU Skylab Incubator, which is one of several examples of Danish universities' support of the entrepreneurial scene in Denmark. The Incubator has its

REEL PR PHOTO

Our biggest challenge has been to navigate between all the opportunities that Denmark has to offer. Within the greentech industry, a lot of the programmes offered are starting to specifically address greentech start-ups.

– JON SIGVERT, CO-FOUNDER, REEL

own co-working space and supplies its participants with mentoring and access to soft funding, as well as exposure to investors and stakeholders from the greentech industry. Sigvert is eager to emphasise the crucial role DTU has played in making Reel a reality:

"DTU gave us the stepping-stone we needed. We were able to work on the project whilst still being students. We were able to utilise the entire start-up ecosystem at DTU, matching us up with relevant stakeholders. At the same time, we were connected to other students – we even met some of our current team members through the entrepreneurship course."

As part of the entrepreneurship course, Reel participated in the course's start-up competition on DTU's Innovation Day, winning rst place, which earned Sigvert and Real the prize of DKK 200,000. The prize was funded by the private venture fund PreSeed Ventures, further underlining how Denmark succeeds in bringing together start-ups with actors from private industries and universities.

A COUNTRY FULL OF OPPORTUNITIES

According to Sigvert's experience, there is an abundance of opportunities available to greentech start-ups in Denmark – both through private partnerships and through state-supported programmes:

"Our biggest challenge has been to navigate between all the opportunities that Denmark has to offer. Within the greentech industry, a lot of the programmes offered are starting to speci cally address greentech start-ups."

Through recommendations made by other start-ups in the DTU Skylab Incubator, Reel has also joined the Climate-KIC Nordic accelerator programme supported by the European Institute of Innovation and Technology, which has led to three rounds of funding for Reel:

"It feels like we have been going from one exciting programme to the next, and we have been able to improve and evolve the product and the company very fast. It has truly been overwhelming to receive so much help, mentoring and funding from these people and programmes."

Most recently, Reel has been given a place on the Innofounder graduate programme offered by Innovation Fund Denmark. The 12-month programme gives the participants access to mentoring resources as well as a co-working space with other start-ups, whilst at the same time providing the start-ups with a salary, allowing them to invest their energy into the start-up full-time throughout the programme.

WORKING ALONGSIDE PEERS FROM THE START-UP SCENE

As part of the DTU Skylab Incubator, Sigvert has been able to work at the coworking spaces at the Incubator, sharing the space with 11 other start-ups:

"The start-up environment is so strong and there is so much support from everyone. The time we spent there [at the Incubator workspace] was so motivating. You are surrounded by others who are in the same position as yourself, and we support each other in developing our start-ups. People work hard and everyone is doing something that they are so passionate about, wanting to make a mark on sustainability as quickly as possible."

Even though the start-up environment can be fast-paced and involve long hours, Sigvert's experience is that there is great emphasis on not working too hard:

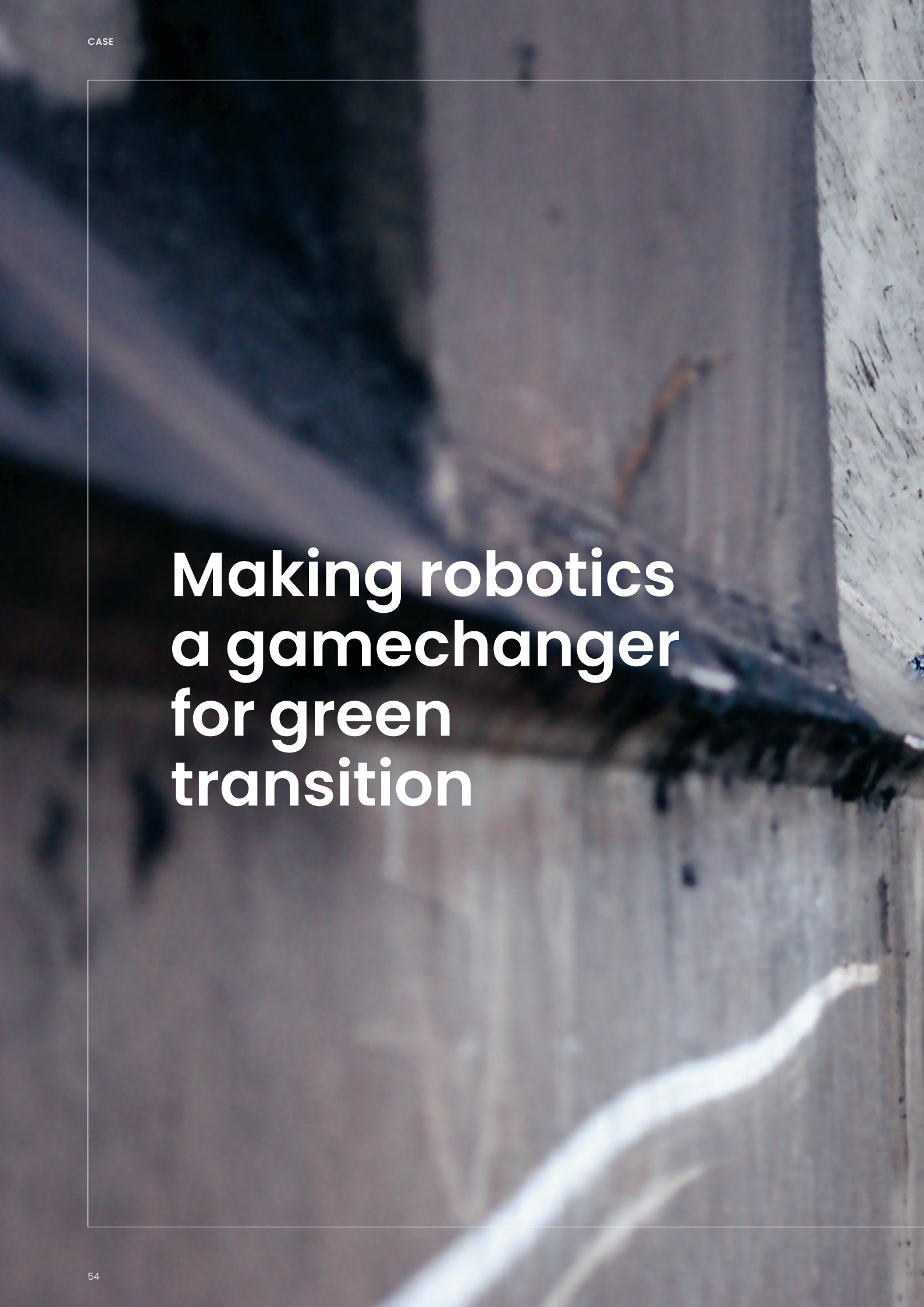
"There is no use in burning out already. We need to look out for ourselves too. The coaches and mentors that we met through the Incubator all attach great importance to this."

TAKING THE PLUNGE TOWARDS A GREENER FUTURE

Having been a bit nervous in the beginning about taking the leap from student to entrepreneur and co-founder of a start-up, Sigvert soon found that his nervousness had been unnecessary:

"We had such a soft landing in the start-up scene with so much support that I can only recommend others to throw yourselves into it. In our experience, there has been so much help to get from everyone and there are so many programmes that provide whatever support your start-up needs."

Sigvert is currently preparing to take another plunge as Reel expects to launch their product at the beginning of 2022.



Making robotics a gamechanger for green transition

CLIIN PR PHOTO

Danish start-ups are building robots to deliver clear sustainability gains for business across sectors and regions.

COMPANY:
Cliin

CEO & CO-FOUNDER:
Thomas Jørgensen

SPECIALITY:
Robotics for sustainable cleaning in shipping

CLIIN PR PHOTO

The Danish robot industry is rapidly growing. Even though Denmark entered the game late, it has quickly become a frontrunner in the robotics field. Where other nations such as Sweden and Germany began aligning their robot clusters with the automobile industry in the 1970s, the Danish robot industry started to accelerate more recently in the early 2000s[1]. Since then, growth has been overwhelming with the export of industrial robots increasing sixfold from 2014 to 2018 – surpassing heavyweights such as the US, Sweden and Holland.

This rising market is not expected to drop any time soon. Damvad Analytics forecasts a doubling or even trebling of revenue for the robotics and automation industry from 2019-2025[2]. The Danish robots are not only for export, however Denmark is one of the leading countries in the world when it comes to the use of robots in industry and has a population with the most positive attitude towards robots in the EU[3].

In February 2020, the Danish government launched Denmark's first national robot strategy. The strategy stresses the green potential in the use of robots, emphasising that robots can strengthen productivity and competition while also supporting the green transition. Minister of Education and Research, Ane Halsboe-Jørgensen, underlined this potential when speaking at the launch of the strategy:

"We must take advantage of the fact that we have one of the world's leading robot industries and at the same time ensure that it also contributes to the green transition."

ROBOTS CONTRIBUTING TO THE GREEN TRANSITION

The robotic field is a crosscutting industry that contributes to almost all other sectors, with robotic and automated solutions finding their way into farming, shipping, building, healthcare, transport and many other sectors. A recent report from the company Odense Robotics and the University of Southern Denmark identifies four different ways in which robot companies support the green transition. Robot solutions can help reduce energy consumption, resource consumption and pollution, and can contribute to reusing recycled materials[4]. As Mikkel Christoffersen, CEO at Denmark's national robot cluster Odense Robotics says: "Green transition doesn't mean stopping consuming and producing, but instead consuming and producing in a sustainable way. It's here that robot companies can play a big role."

[1] *Robotics Alliance & IRIS Group (2019). The Danish Robotics Cluster in a Global Perspective. See https://robotics-alliance.dk/wp-content/uploads/2019/12/The-Danish-Robotics-Cluster-in-a-Global-Perspective.-Dec2019.pdf*

[2] *Damvad Analytics (2019). Analysis of the Danish robotics industry – A position of strength on the rise. See https://robotics-alliance.dk/wp-content/uploads/2020/01/Analysis-of-Denmarks-Robotics-Industry_Damvad-Analytics-April-2019.pdf*

[3] *Eurobarometer (2012). Public attitudes towards robots. See https://ec.europa.eu/commfrontoffice/publicopinion/archives/ebs/ebs_382_en.pdf*

[4] *Odense Robotics & the University of Southern Denmark (2020).*

Green robot solutions support:

*** ENERGY SAVINGS:**
Most robot solutions have lower energy consumption and CO2 emissions than traditional industrial processes. In addition, when robots are integrated into IoT or smart systems, they become an integral part of an interconnected system that typically takes up less space and uses less resources.

*** IMPROVED RESOURCE CONSUMPTION:**
Robot technology can reduce resource use beyond energy, and can minimise water and chemical use as well. And robots can often optimise the use of materials for production, by improved calculations, streamlining processes or preventive measures like monitoring and maintenance.

*** PREVENTING POLLUTION:**
Robots make it possible to substitute polluting chemical processes with mechanic processes, for cleaning tasks, where automation makes chemicals less necessary, or agricultural tasks, where intelligent robots can reduce water and chemical use by applying high precision GPS tracking.

*** CONTRIBUTING TO RECYCLING:**
Valuable resources are lost in dealing with waste that is dangerous to sort, but with robots, potentially hazardous waste can be handled for reuse.

Source: Robot Technology and Green Transition, Odense Robotics and SDU.

COMPANY:
Robot At Work

CO-FOUNDER & CTO:
Finn Kierkegaard Christensen

SPECIALITY:
Flexible robotic platform for construction sites

ROBOT AT WORK PR PHOTO

Even though not all robotics companies pro le their products as green solutions, most of them contribute to the green transition without even trying. By focusing on optimising energy and resource consumption and the reduction of waste, the surplus on the nancial bottom line is also a surplus on the environmental bottom line. Looking forward, Christoffersen expects a rise in demand for robot suppliers to also make clear how their product contributes to the green transition, and he considers the Danish robot companies to be ready to meet this demand.

ROBOTS ARE REPLACING CHEMICALS IN THE SHIPPING INDUSTRY

One robot company ready to take on the green transition is Cliin. It has developed a cleaning robot for cargo holds for the shipping industry. Traditionally, the cleaning of cargo holds is a tedious manual job that involves the use of a lot of chemicals and takes place in a hazardous work environment. Cliin's robot tackles the three D's of robotisation by replacing dirty, dull, and dangerous work. Instead of having workers do the cleaning hanging from the ceiling or knee-deep in chemical waters, the robot is controlled remotely and does the cleaning faster, cleaner, and without exposing workers to a hazardous work environment.

In short, it is not only the work environment that bene ts from the robot; so do the world's oceans. CEO and co-founder of Cliin, Thomas Jørgensen, explains: "100s of millions of litres of chemicals per year are used on cargo hold cleaning. It ranges from soaps to very powerful acids and alkali bases. All of it is being let out to sea after completion of the cleaning. People do not know this, because they have no idea what is going on these ships. As soon as you are on the open sea, you can dump whatever you want, which is very harmful to our marine life." Jørgensen adds: "With our underwater hull robotic concept that is currently under development, we can theoretically reduce the world eet's CO2 emissions by as much as 15% if our product is going to work. Which is crazy! Those are huge numbers."

THE FUTURE OF GREEN CONSTRUCTION: NEW MATERIALS AND LOCAL ROBOTS

Another industry where robots are having a remarkable green impact, is the construction industry. The focus on sustainability in the construction industry has exploded during the last two years, according to CTO and co-founder of Robot at Work, Finn

How to succeed in the robotics eld

"Creating a network of advisors is important, but you also have to listen to your gut feeling. It's a super difficult balance but go for it! You might only get that one chance."

– THOMAS JØRGENSEN, CEO AND CO-FOUNDER CLIIN.

"There is no one who can lift a company alone. Getting the right people into the right positions is the alpha and omega of success."

– THOMAS JØRGENSEN, CEO AND CO-FOUNDER CLIIN.

"The key to our success is that we have tested and dared to test and dared to fail in our development."

- FINN KIERKEGAARD CHRISTENSEN, CTO AND CO-FOUNDER ROBOT AT WORK.

Danish robot companies are born global

"Denmark has a large robot industry and is a very significant player in the development of the robot and drone industry worldwide."

– MIKKEL CHRISTOFFERSEN, CEO ODENSE ROBOTICS.

"On Funen alone, from 2015-2019, DKK 6 billion has been attracted in investments - primarily from global investors."

– MIKKEL CHRISTOFFERSEN, CEO ODENSE ROBOTICS.

"We are present from Chile to Japan to Australia, Canada, South Africa. We are all around already. Because shipping is global."

– THOMAS JØRGENSEN, CEO AND CO-FOUNDER CLIIN

"We consider Denmark as a test country, where we show what our robot can be used for and from there, we will scale out internationally."

- FINN KIERKEGAARD CHRISTENSEN, CTO AND CO-FOUNDER ROBOT AT WORK.

We must take advantage of the fact that we have one of the world's leading robot industries and at the same time ensure that it also contributes to the green transition.

- ANE HALSBOE-JØRGENSEN,
MINISTER OF EDUCATION AND RESEARCH

Kierkegaard Christensen. An increased focus on more sustainable materials and recycling has become very popular, and the robots are very good at handling the new building methods that are required. Christensen explains: "There is a ne crossroads between the new sustainable materials that emerge and robot technology. The two go hand in hand to create a much more sustainable building mass in the future."

A common denominator in the green potential of robots is the reduction of transport. Global value and supply chains, where production of parts is scattered around the world, cause a lot of environmental and nancial expenses related to transportation. With robots the outsourcing is not geographically determined because the robots are transportable. They can be built where the materials are or where the end customer is, and the different components do not have to be transported, which reduces the total climate impact within the supply chain. At Robot at Work, they have developed a robotic solution that can be combined in many ways to do multiple tasks – according to Christensen, much like LEGO building blocks. The solution is primarily targeted at the construction industry, where the technology is applied to develop cutting robots, milling robots and 3D-printing robots. "Sustainability and climate friendliness have many faces when we talk about our robot, because it can be used for many different solutions," Christensen explains.

Recently, Robot at Work has been working on combining the robotic LEGO blocks to make a 3D-printing robot that will be able to print an entire house out of recycled plastic. With 3D-printing, building waste is minimised, and with the use of recycled plastic it is possible to take harmful waste and turn it into something useful. Christensen further explains: "If you have a lot of plastic waste from the world's oceans or elsewhere, in Peru for example. They can have a 3D printer delivered through us and the 3D printer can be set up locally and it is plug and play. This means that they can take the plastic waste they have locally, have it made into plastic granules - it is again part of the machine - and then they can actually print whole houses in full size." Solutions like this not only tackle the issue of more sustainable materials, but also tackle the issue of transportation.

"What we do is what is called a local factory. So, you have very minimal transport with these solutions," Christensen says.

LEARNINGS FROM ROBOT START-UPS

For many companies in the robotics eld, the development of a robot from scratch is time-consuming and requires funding. In the case of Cliin, the company sought out a strong testing environment and found Danish shipping companies to collaborate with in the development phase. This proved less of a challenge than rst anticipated, because many partners can see a de nite upside to Cliin's robot solution in the long run. In fact, Cliin's CEO, Thomas Jørgensen, recommends other start-ups to focus on getting the right people on board and not to be afraid of relinquishing part of the ownership in the company. In the end, you cannot carry a company by yourself.

Finn Christensen at Robot at Work explains that the main challenge encountered, from idea to marketable product, was the technical development. Drawing from his own experiences, his advice to those who want to innovate in the robot industry is not to develop a robot from scratch. Instead, he points out that when it comes to the potential of widespread robots, a lot of technology has already been developed and tested, and much of it can be further developed to different usages and applied to multiple sectors. The possibilities are numerous, and a lot of basis technology is already in place. It is just about getting started.

PREPARING FOR A GREEN TRANSITION

Danish robot companies are rapidly progressing, and the entrepreneurs have a global outlook.

Although many robot companies do not yet brand themselves as greentech companies, most robotic solutions come with a hidden green bonus. There is a vast potential to add environmental sustainability to their value proposition – and go beyond the focus on eliminating dull, dirty, and dangerous work.


Define full Tr and F operators:

Nuclear power. It's part of the solution

SEABORG TECHNOLOGIES PR PHOTO

One Danish company dares to build sustainable nuclear reactors.

COMPANY:
Seaborg Technologies

CO-FOUNDER & CEO:
Troels Schönfeldt

SPECIALITY:
Next generation nuclear reactors

Climate change does not respect national borders. This truism carries another related message. If the problems are global, we cannot limit ourselves to creating local solutions. What works at home, under the serene Nordic lights, will not necessarily work for other countries, with different economies, regulatory frameworks, culture, geography and climate.

This is partly the story of Seaborg Technologies. Founded in 2014, it has spent the better part of seven years building a sustainable energy solution that is unlikely ever to be implemented in Denmark. And that's the point. It was designed for regions troubled by a speci c dilemma.

Those are the regions, for example in South East Asia, that experience a rapid rise in energy demand, while currently having no realistic alternative to fossil-fuel-based energy. Renewable energy sources like wind and solar power are hard to sustain when you have monsoon rains for three months every year, when you have too few rivers to establish hydropower at suf cient levels and when your population density makes the region ill-suited for biomass burning. In all these cases, what makes the most sense is to go down a different path: nuclear energy.

SEABORG TECHNOLOGIES LIFT-OFF

"We were tired of seeing that many of the technologies we already have, and that we know as a fact must be part of the solution-mix, like nuclear power, are not seriously considered," says Troels Schönfeldt, thinking back to the early motivations for starting Seaborg Technologies. He elaborates, "We hadn't expected to get this far. We just wanted to show that something could be done here, and we hoped to create a more nuanced public debate". In fact, Schönfeldt and his co-founders were mostly eyeing the chance of being picked up by incumbents in the energy eld, so they could help them develop nuclear power solutions.

I don't think people really understand the problem. There is a world out there with over six-and-a-half billion people who need more energy. And one of those billion has no electricity at all.[1]

– TROELS SCHÖNFELDT, CO-FOUNDER, SEABORG TECHNOLOGIES

[1] *https://ivaerksaetterhistorier.dk/seaborg/*

Seaborg's expected green technology impact

- *By 2025 Seaborg expect to deliver a commercial full-scale prototype for their molten salt reactor.*
- *Before 2030 Seaborg hope to supply reactors that reduce yearly greenhouse gas emissions by the equivalent of Denmark's current emissions.*
- *The 2040 target is to distribute 8975 CMSRs creating CO2 reductions on par with the EU's current yearly carbon footprint.*

Source: www.videnskab.dk and www.seaborg.co

That did not happen. Fast forward some years and Seaborg Technologies has now grown from three physicists brewing beer and discussing existential threats, to a fastly expanding company employing over forty nuclear engineers, physicists, chemists, safety experts and business developers. Its growth trajectory continues upwards, not least due to ambitious partnerships with South Korean companies with which Seaborg can deliver 7500 reactors by 2040. Add to that a recent investment from the Heartland holding company, the latest incoming capital, adding to early-stage investments from the founders of six Danish unicorns, amongst others.

NUCLEAR ENERGY CONTRIBUTING TO THE GREEN TRANSITION

Before you write off the idea of modern nuclear power, perhaps because of disastrous events in the past, spend a few moments learning more about the next generation of nuclear power plants that are currently being developed. Remarkably, at least to most laymen, experts agree that these reactors are much safer, reduce waste, are smaller and cheaper, cannot melt down, explode or be applied to the development of nuclear weapons, and emit zero greenhouse gases[2].

It is important to keep sight of the bigger picture. Global energy is increasingly based around electricity, which means the key to making energy systems clean is to transform the electricity sector from the largest producer of CO2 emissions into a low-carbon sector, especially in areas like transport, heating and industry. And while many experts agree that renewables will continue to lead this transition, nuclear power has a necessary and vital role to play. One reason for this is the short time we are afforded to make such changes. To achieve a trajectory consistent with the international climate goals,

[2] *https://videnskab.dk/teknologi-innovation/fremtidens-atomreaktor-er-lille-og-koerer-maaske-paa-smeltet-salt*

the expansion of clean electricity needs to be three times faster than at present. According to the International Energy Association (IEA), it will require 85% of global electricity to come from clean sources by 2040, compared to just 36% today. That means it would also need an 80% increase in global nuclear power production by 2040.

IMPACT IN THE FORM OF A SMALL, MOBILE REACTOR

The idea behind the Seaborg solution is to build and distribute a new type of nuclear reactor, a compact molten salt reactor (CMSR), which differs from existing technologies. Instead of running on uranium or plutonium in solid form, like traditional nuclear power plants, the radioactive material is chemically bound in a liquid salt, which can solidify and doesn't emit radioactive gases. These reactors are much simpler to design and build than their traditional ancestors, and will be both smaller and cheaper to produce. In practice they can be built remotely, shipped around the world in 20-foot containers, set up on large marine vessels in harbours where they are plugged into the local energy grid.

The total resource consumption of the CMSR is also extremely low, making it one of the world's most sustainable sources of energy. And compared to conventional nuclear power sources this small, compact reactor has a relatively low use of resources (below one-third) and is designed to reuse many waste outputs.

The idea is to supply regions of the world that do not have the possibility to transition their energy system to renewables. Beyond this, Seaborg's reactor and nuclear power can complement variable renewables like wind and solar because it is more stable and not dependent on weather conditions. Small modular reactors, like the CMSR, can produce energy wherever and whenever it is needed.

BATTLING THE GHOSTS OF YESTERDAY. LEARNING FOR TOMORROW

"We still experience quite some friction because we say nuclear," Schönfeldt comments, when asked what barriers they have had to overcome. He explains that the very

Seaborg's modular compact molten salt reactor

- *As a power plant, the CMSR will be able to deliver electricity, clean water and heating/cooling to around 200,000 households.*
- *Additionally, the outlet temperature of the reactor is high enough to efficiently produce carbon-neutral hydrogen, synthetic fuels and fertilisers.*
- *The CMSR emits no greenhouse gases while operating and has the lowest resource use of any energy technology.*
- *CMSRs on a barge equals the energy production of 20Km² wind energy parks.*

Source: www.seaborg.co and interview with Troels Schönfeldt.

SEABORG TECHNOLOGIES PR PHOTO

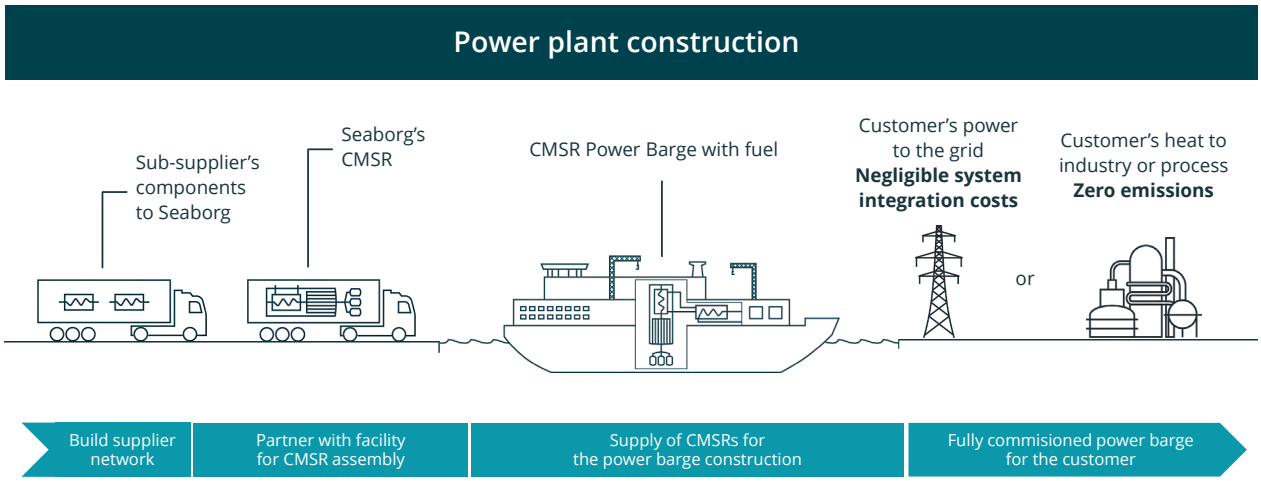
We all agreed that this would be completely impossible. We tried anyway and then one day we find ourselves being a global frontrunner.

– TROELS SCHÖNFELDT, CO-FOUNDER, SEABORG TECHNOLOGIES

SEABORG

Delivering energy

Centralised construction, worldwide distribution



Source: www.seaborg.co

phrase "nuclear power" becomes a signi cant barrier, and although they could certainly tone this down and instead talk about all the spin-off possibilities from this technology, with which business-minded people are eager to get on board, they choose not to. "It will defocus us," he says. "Nuclear power is an unavoidable part of the solution. If we don't even dare say the word or talk about it, then we simply won't solve the climate crisis."

Pressed on the matter, Schönfeldt says that to be fair, things are slowly changing. Tracking back ve years there were no politicians who were positive towards nuclear energy solutions, and then something happened. The United Nations Climate Panel, IPCC, came out and proclaimed that there is no sustainable energy scenario that does not include nuclear power. That had an immense impact, and today Danish politicians are also shifting from being "blind adversaries, to at least recognising this as an option," as Schönfeldt puts it.

Another thing that the team at Seaborg Technologies have had to confront is what Schönfeldt terms "an aversion towards being visionary in the moment", something that he thinks is especially present in a Danish context. Nobody wants to take risky bets, but many seem to forget how Denmark came to be a world leader in wind energy. And as Schönfeldt concludes, if the green transition is the biggest challenge humanity has had to face, it is not going to be easy. "So, we need investments in research and high-risk innovation projects."

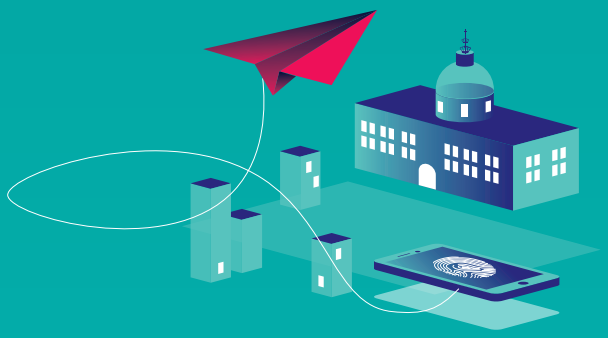
That being said, the upside is that Denmark boasts ambitious and game-changing innovations, many of which could have an immense impact, if they are given the right support. And asked to produce some personal advice to innovators and entrepreneurs, Schönfeldt is adamant: "Do it, do it, do it – the point about climate change is that we all have to do our part and try. We will not get there without trying."

Alongside renewables, energy efficiency and other innovative technologies, nuclear can make a significant contribution to achieving sustainable energy goals and enhancing energy security.

– FATIH BIROL, EXECUTIVE DIRECTOR, IEA[3]

[3] *https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system*

THE FUTURE STARTS NOW



The biggest challenge is to bring more talent into the impact tech space. Creative and empathetic people with a great mindset, who have strong tech and business skills yet understand impact investing.

- THARALD NUSTAD, CO-FOUNDER, NORDIC IMPACT AND KATAPULT

The latest reports on global warming and the so-called sixth mass extinction are alarming. We are beyond sugar coating the research findings and the call to action from the expert community. In fact, realistically, these planetary emergencies could lead to the collapse of civilisation as we know it, unless we produce rapid and far-reaching changes in every aspect of our economic system.

The speed and scale of the transformation we need has no historical precedent. To say that the 2020s will be decisive would be an understatement. By 2030 we need to achieve both the SDGs and the first halving of carbon dioxide emissions as part of the "carbon law"[1]. In the next decade, we need to prevent breakdowns and devise breakthroughs – the solutions to global challenges that sustainability pioneer John Elkington calls "Green Swans". To confront these challenges and harness the power of emerging technologies, science and business entrepreneurship, we need to address some key priorities.

RAISE OUR AMBITIONS

A growing cohort of start-ups and corporates claim to be purpose-driven and provide climate mitigation solutions for partners, customers and society at large. Indeed, companies with a net positive impact on the environment will be best positioned to attract and retain talent, keep their licence to operate and thrive in both existing and new markets. However, not only do the number of such ventures need to increase fast, but their ambitions should also be bolstered to committed targets and impact audits. We must act now by setting short-term and long-term targets in every aspect of company strategy. This will require us to escape the tyranny of short-term results, to focus instead on long-term value creation. By leveraging growing ambitions, and being transparent about efforts, targets and measurable impact, investors and greentech talents will convene around the most promising and value-creating solutions. This is true for Denmark – we have seen it in the case of companies like AgroIntelli, Cliin and Plant Jammer to name just a few – and it is true when looking out into the world.

FIND PEERS, CREATE NETWORKS AND CLUSTERS

Businesses should join or create coalitions with sector peers and other stakeholders, to share knowledge, unlock bigger opportunities and tackle problems that are too big for one organisation alone. As we have seen, this can take place in the context of cross-sectoral business innovation clusters, like Odense Robotics or Center Denmark and start-up impact accelerators like Nordic Impact Hub and +Impact. Whether they are centred on a sector, a technology, a region, or the sustainability issue itself, the primary learning is that they provide a support structure that is decisive for greentech solutions to scale and have real impact. As with some of the cases we have covered, collaboration and partnering are clearly not only about improving the status quo of each individual company or organisation – it makes even more sense since some green business opportunities only present themselves in the midst of collaborative efforts.

EXPAND THE TALENT POOL

Attracting the best talent is often the biggest bottleneck, in both tech and environmental impact – often even more than raising capital. To really deliver on high ambitions, companies can do even more to attract greentech talent. Given the high levels of safety, work-life balance and organisational purpose present in a Danish context, there is a strong foundation to build from as we move forward. Some companies are just waking up to the recognition that they might be robotics companies, but they are in fact also greentech companies, and this can provide them with a marketable edge to attract new talent. Also, instead of recruiting talent solely through the usual channels, the next move would be to engage the growing number of university programmes that are integrating environmental sustainability and digital innovation, like Sustainable Biotechnology at Aalborg University or Sustainable Energy at The Technical University of Denmark and others. In the end it also comes down to telling green technology success stories, and identifying role models and experienced mentors to lean on and be inspired by.

MOVING ONWARDS

All stakeholders have an opportunity to step up and do their part to deliver on this momentous challenge, which by all accounts is also a great opportunity. Not exactly a blue ocean or a red one, but a green one, to be sure.

There is no easy sailing ahead, because so many efforts are recognising the urgent need to create viable sustainable solutions, hence competition is already mounting. On the other hand, we should welcome growing competition, creating new marketplaces, while sidestepping the short-termism of some tech investors and boards, who are more concerned with exit strategies than creating enduring sustainable outcomes. A green ocean presents itself to start-ups, businesses, investors and greentech talents who venture into unknown waters certain that thriving market innovations are grown from shared values.

[1] *https://ec.europa.eu/environment/integration/research/newsalert/pdf/carbon_law_could_lead_to_zero_global_emissions_by_2050_508na1_en.pdf*

People we have interviewed

Anders Eldrup, Chairman, The Danish Green Investment Fund

Anders Hinrichs, Lead Product Engineer, WasteHero

Anders Lendager, Founder and CEO, Lendager Group

Barbara Taudorf Andersen, professional board member, start-up investor and advisor

Charlotte Searle, senior data analyst, Too Good To Go

Claus Andreas Foss Rosenstand, Professor, Digital Hub Denmark

Claus Møldrup, founder and CEO, Drugstars

Finn Kierkegaard Christensen, co-founder and CTO, ROBOT AT WORK

Jakob Lage Hansen, CEO, DoLand

Jon Sigvert, co-founder, Reel

Lise Walbom, CEO, FOOD NATION

Mette Kramer, consultant with SEGES

Michael Haase, founder and CEO, PlantJammer

Michael Stanley Pedersen, CEO, FaunaPhotonics

Mikkel Christoffersen, CEO, Denmark's national robot cluster, Odense Robotics

Niels Fibæk Jensen, CEO, Matter

Ole Green, CEO, Agrointelli

Thomas Jørgensen, co-founder and CEO, Cliin

Troels Schönfeldt, co-founder and CEO, Seaborg Technologies

Varan Pathmanathan, CEO, MakeImpact

Digital Hub Denmark