top engineer

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"Finland has considerably more production potential of biogas than is currently being utilised."
– Anne Kujanpää
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Consulting • Engineering • Design • R & D • Innovation • Technical Solutions

Big challenges bring big opportunities

The importance of technology is growing, which makes many issues become solvable. In order to reach the set carbon neutrality goals, we need to be both determined and innovative. We must work hard and deploy technologies that will give us the solution for a clean and carbon neutral world.

Companies can no longer ignore humans and the environment; they are required to have measures for managing a sustainable economy, environment and people's wellbeing. Investors and financing institutions are already making decisions from the viewpoint of responsibility, which is examined based on the ESG (Environmental, Social and Governance transparency) criteria, for example.

It is obvious that we must give fossil fuels up in a controlled manner. However, there is no individual energy solution that could replace all fossil-based energy sources. The overall solution must be formed from several different technologies. For example, hydrogen production with renewable energy and utilising it both directly and in the manufacturing of synfuels are one significant trend.

Traffic is one of the biggest users of energy and the development of its energy sources still requires a lot of work. For example, using hydrogen in marine traffic is noted to have a lot of potential, but at the same time, many issues remain unsolved. The challenges include the use and storing of hydrogen in the energy density of bunker fuel.

Finland has a lot of competence in circular economy. Through industrial processes, new materials are created for reuse from existing materials and natural raw materials. When it comes to different forms of energy, raw materials appropriate for a biogas plant are created in huge amounts in both nature and the society's operations.

Entire factories or plants can also be built with recycled parts or they can be turned into some other new production plant. Using recyclable machines can be a considerable advantage when compared to brand new machines.

According to the European Parliament, the clothes industry's share of the environmental impact of the EU's consumption is 2–10%. From 2025 onwards, an EU directive will require all end textiles of consumers to be collected separately. At the moment, the majority of textile waste is thrown away and the proportions are huge – annually over 70 million kilos of unused material in Finland alone. Thanks to new technologies, the majority of this resource can be used again in the creation of new clean fibre.

All this provides companies with a lot of new business opportunities whose benefits and additional values will also affect greatly the future generations' quality of life. Big challenges are interesting planning exercises and we at Elomatic are, together with our customers, involved in the work for improving the well-being of people and the environment. Part of this is our development of new innovations, such as our artificial island concept, which you can read more about at the end of this magazine.

Happy reading and let us work together for a clean future!

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Content

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Financing the Green Transition

Text: Heidi Käkelä

The energy sector must commit to acting in concrete ways against climate change, structural inequality and social alienation if they hope to be financed through a growing number of ESG funds. This will take some time, a bit of effort and more soul-searching than we are perhaps used to.

To borrow a thought from the Lebanese-American poet Khalil Gibran, the Green Transition is a "responsibility, not an opportunity." Although we have known since the late 70's and the early 80's that catastrophic climate change is a possible scenario, committed and significant change has been slow to materialize within the energy sector. The reasons are many: the world is developing at varying paces, energy chains are complex and interlocking entities and the capital costs of new technology must not outweigh the rate of reasonable return. Even realpolitik dictates that not all alternative means of generation are viable.

Nevertheless, the consequences of human inaction are already starting to show, and we are facing a world of decreasing wellbeing, unrest and urgency that demands we act. The energy sector has a pivotal role to play in this, as the lion's share of the world's emissions are produced through its actions. With the European Green Deal, the legal codification of the EU's climate goals and the sharp developments in the Emissions Trading System, Finland's energy sector is currently under increasing pressure to reform. Simultaneously, a persistent investment gap has been identified in our industrial sector, which poses the question: how should energy companies finance the Green Transition?

The New Normal

No matter what humankind's relatively short memory would have us believe, global shocks are the norm rather than the exception. In fact, they are so commonplace that adapting to them often gains the moniker "the new normal", which refers to the conceptualization of a time of blissful ignorance in the before and a time of slow reconstruction in the after. At the moment of writing, in the spring of 2021, it is hardly difficult to envisage the newest "normals" that we have come to know. With its acuteness, the Novel Coronavirus pandemic has served both to overshadow and to bring into stark contrast many of the problems that faced global societies far prior to its arrival. These include not only environmental concerns but also growing economic inequality digital and social alienation, reckless populism and the acceleration of destabilizing conspiracy theories. It is clear that the World is becoming more splintered in a time

“Crisis”

krino, krisis (Greek): to judge, to prefer one alternative over another

An illustrative analogy by sociologist Loïc Wacquant describes a crisis as a rowing boat exactly in the middle of a quickly flowing stream.

At this point, equally far from both shores, one must commit to a direction or be swept away.

of increased need for cooperation and unity, which makes the case for adaptation and positive action all the more important.

Conscious Capitalism

The growing adoption of corporate social responsibility (CSR) policies is one of the better types of new normality to come from the increasing global awareness enabled through digital interaction. It is no longer possible for successful businesses to ignore the world around them and the best will attempt to get ahead of the curve of conscious action. For Finnish energy companies this refers particularly to their relationship with national and international climate targets, their relations with an expanding set of active stakeholders and demands for corporate transparency; these issues converge in the acronym “ESG”, which is bank-terminology for environmental, social and governance criteria.

Financial institutions use ESG criteria as a means of guiding socially responsible investment, which includes a large number of financial instruments, such as equities, bonds and loans. Historically, ESG criteria have informed divestment rather than investment, where certain investors and institutions have been unwilling to invest in problematic businesses, such as the fossil fuel industry or tobacco companies. Today, ESG investing takes an active role in channeling funding towards sustainable and green activities in a financially robust way. ESG is also a growing force in global markets, where sustainable and green investment funds outperformed many forecasts even throughout the stormy waters of 2020.

From a business perspective, attracting ESG investment is fundamentally a form of risk management, as it signals good corporate citizenship beyond the traditional balance sheet. Sustainable businesses are at

the forefront of recognizing their impacts in a broader context, be it environmental, social or political, and they are thus better protected from market shocks. For an energy company, ESG criteria might be tied to airborne emissions, but also to water management, noise and light pollution, HSE, equitable recruitment and remuneration policies, and to ethical supply chains. None of these issues are a surprise to a responsible actor in the Finnish energy sector; what's new is how they can affect its access to financing.

Beyond ESG investment through equities, which is currently the most prominent, there exists a growing market in green bonds and loans. Green bonds are strongly characterized by their bond frameworks, which clearly state the conditions under which the bond has been established and the rules by which its proceeds may be disbursed. Bond frameworks are developed to be compliant with a number of internationally established codes of conduct, such as the UN Principles of Responsible Investment, the Equator Principles or the aptly named Green Bond Principles. In the future, green bonds can also be developed according to the EU's Green Bond Standard, which will automatically ensure that they are eligible for "green" status within the Union.

This is no mean feat, since with the anticipated adoption of the EU's Green Deal and especially its technical specification, the Taxonomy, energy companies will be subjected to new expectations and limitations. These expectations concern especially how projects are defined as environmentally friendly. Another option for energy companies is to take out green loans from banks that have already established green bonds in advance. Projects that are nominated for these loans go through an in-bank approval process, where their environmental credentials are investigated by sustainability analysts and, if they are found compliant with the green bond framework, awarded with green financing. Often, this green financing is also significantly more affordable than its regular counterparts, thanks to its managed risk.

Green forms of Financing

ESG Investment
Green or climate funds invest in equity from companies that meet their ESG criteria. Often ESG funds are active shareholders that look to ensure that companies adhere to these criteria.

Green Bonds
Green bonds are bonds most commonly released by companies or banks. They are regulated through green bond frameworks that set out clearly defined categories of green projects or activities that can be financed through the bond.

Green Loans
Green corporate loans are a finance instrument offered by banks that have often released a green bond of their own. Candidates for green loans are screened by the bank's own specialists and are subject to the requirements set out in the green bond's framework.

Green Transition compliant engineering

The Green Transition is an all-encompassing endeavor; it runs through every part of Finnish society, and coming to grips with it is sometimes a daunting task. Changes are suggested, mandated and adopted on multiple levels simultaneously. On one day, we might struggle to rise to meet the EU's demands, the second we engage with local environmental organizations and obligations, and on the third we must maintain and improve the company's own generation capacity.

ESG investment offers an alternative for a structured approach to transforming regular business into green business, but attracting it requires a broader overhaul of styles of thinking about engineering. ESG criteria are best met through the readiness, willingness and ability to see beyond the crisis and to commit to effective action to mitigate it. There are no easy answers for how to meet these challenges, but there are some questions we might start with.

Transparency makes responsibility easier

Do you know what you already know? – The basis of ESG finance is knowledge and the key to it is communication. Energy companies generate information in droves – daily, monthly, yearly. Some of this knowledge is gathered and made public through corporate reports, other parts inform the company's function and advise its plans for the future. All of it can potentially be used to communicate responsible business practices and good commitments, which have a signaling effect on the surrounding society. The increase in data-led and data-driven business began as early as the 1990s, but it is becoming mainstream only now as more companies are making the slow shift to relying more strongly on the interpretive and interdisciplinary field of data science. One of the many benefits of making use of data streams is increased trust in corporate practices. This translates to better access to both public and private funding, which can potentially make up for some of the perceived failings of the Finnish economy and boost investment into lucrative and sustainable solutions.

Are you trying to do this alone? – The pandemic has taught us that our societies are far more vulnerable than we ever expected. A lesson business might take here from disaster relief and reconstruction is that although centralized large actors are never adept enough to best meet local needs, no one is equipped to handle a catastrophe on their own. Co-operation is arguably the best human quality with regards to community survival, and while companies have obviously gathered around shared interests in the past, they should be open to some of its newer forms now. An example of these is asymmetric business ecosystems, which have formed around data-sharing between large companies and SMEs, another one is international business clustering, which has strong backing from the European Union and is sometimes even a prerequisite for easier access to some of its funding, such as COSME or Horizon Europe. These partnerships may be varied in kind and interconnection, but they share an ethos of pooling resources and the commitment to a common goal.

While curiosity makes for better CSR

Do you know what is important for your stakeholders? – Businesses and individuals alike really should ask more questions. Not only from ourselves (although we are often drawn to think that's where the best advice comes from), but also from those around us who do not necessarily share our views. Openness to a wide set of views correlates with better preparedness in times of uncertainty, because it allows us to form more accurate assessments of the world. Stakeholder engagement has been shown to have beneficial impacts on company practices and many banks managing ESG funds are active shareholders. This type of environmental and social awareness is often behind why even energy companies are currently interested in protecting and increasing pollinators. While most of ESG-related performance is still communicated via Key Performance Indicators (KPIs), the actions that have the best consequences are not always well-quantified. And it is these forms of action that do and will continue to spur sustainability in the energy sector.

How are your most at-risk stakeholders doing? – We should also be willing to own our role in the broader society by engaging more openly with structural issues. On a global scale, Finnish society is among the most egalitarian, but even we face social problems, such as energy poverty. Although the standard of Finnish housing is undeniably good and warrants at least a little national pride, simultaneously, according to EU statistics, the relative share of energy expenditures for Finnish households is significant and abnormally low energy expenditures

Energy Poverty

In the first definition of energy poverty from the United Kingdom (1991), "a household is said to be fuel poor if it needs to spend more than 10% of its income on fuel to maintain an adequate level of warmth". This unofficial definition is still being used across the European Union.

are recorded for 29.9% of them. These figures may have many explanations, such as alternative heat sources and the methodological challenges in accounting for housing cooperatives, but the most unfortunate one is restricted energy spending, which has been estimated to affect 60,000–100,000 households.

By definition, structural problems cannot be solved by any individual actor alone, and the energy sector is no exception. We are an important part of the solution, however, and our awareness and our willingness to speak up are crucial. In order to maintain their credentials, businesses should be able to motivate their actions not only to their shareholders, but – through socially responsible investment practices – also to those directly affected by them.

And tangible things make for a better Green Transition

What are you really doing for the environment? – Regardless of where one stands, energy companies or engineers are never value-neutral. The decision to invest in, design, build and operate a large industrial plant carries implications that all of us can see and appreciate. Therefore, in order to strive for responsibility and sustainability, the actions we take should be as real as the results of our work.

Legal and financial frameworks for green industrial projects are beginning to emerge, but businesses that concentrate on meeting the baseline are not well-prepared to compete against those that go beyond. Best practices often vary, and they can be mapped with the help of stakeholder engagement, but it is important for businesses to articulate their goals in concrete terms and to ensure those goals are met. In the age of Twitter activism, genuinely made but broad and vague gestures at sustainability are just as likely to gain the label of "greenwashing" as those made in bad faith. Consumers, decision-makers and financiers are more than capable of judging corporate responsibility, *"ESG investment offers an alternative for a structured approach to transforming regular business into green business, but attracting it requires a broader overhaul of styles of thinking about engineering."*

and will do so. It can thus be useful and effective to treat sustainability goals as systematically as one might an engineering project, by formulating practical steps, setting attainable objectives and documenting one's efforts, successful and unsuccessful, in a transparent way.

Financing and engineering the Green Transition

The Green Transition requires a push for investment and innovation the like of which has not been seen in our lifetime. It may be the most significant New Normal of the 21st century and its burden on any societal actors, the energy sector included, should not be underestimated. Most of the messages we are shown tell us that we are not on the road to success, which has spurred some understandable counterreactions that either attempt to discount the severity of the issue, to redirect the conversation to other tracks or to show that things really aren't that bad, look. The crisis is here, nevertheless, and once its effects start to cumulate the consequences will concern us all. Fortunately, the ability and the will to act are already evident in the Finnish energy sector and good options to help us undertake the transition are available.

ESG and green finance are examples of a rehabilitated form of capitalism looking to adapt to an environment that no longer supports old modes of thinking. Socially responsible investment forms a set of metrics and classifications being developed to better define what sustainable development means for businesses, which can solidify the concept of how to be a responsible actor in one's field. Attracting ESG financing is a matter of adopting corporate social responsibility thinking as an integral part of one's business model, which begins with a willingness to challenge some of our most entrenched ideas of the world. But it is worth noting that financing the Green Transition will take us only half of the way.

We must also recognize the need to apply sustainability to the way we consult. Perhaps by virtue of its central position for decarbonization efforts, the energy sector today is a relatively climate-aware part of heavy industry. This sets a challenge for us as designers, because in order to best help our clients we must stay ahead of them. The next five years will show the world which technologies will come to dominate the Green Transition, but we as designers and engineers cannot afford to wait that long.

By engaging with ESG and sustainability thinking, this article argues above all that meeting reality where it is allows us a more accurate understanding of it – and a more resilient position alongside it. Engineers should work to meet and even preferably preempt environmental, social and governance issues related to our projects. We already seek to constantly attract, maintain and update our professional knowledge, but we should also open ourselves to the kinds of dialogue that bring us better in touch with the broader society. In a sense, engineering for the Green Transition requires of us what we already do best: solving problems. ESG, sustainability and a broad societal dialogue are what allow us to see those problems better. What we can do to help the transition along is to show and guide our clients towards our common goal: for a cleaner, more equitable and more just world for them, us and everyone else.

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Heidi Käkelä is an environmental anthropologist and energy engineer. Before dunking her foot into STEM, she worked as a researcher studying community responses and disaster reconstruction in the Caribbean, Australia Pacific and Asia, and as an educator in Finland. She is part of Elomatic's International Finance Institutions (IFI) team, which provides engineering expertise for large international development projects, particularly in Central and East Asia, Europe and Russia. She also goes spelunking in EU regulations and funding.

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Photo: Eevi Konttinen

Biogas – renewable energy at its best

Text: Anne Kujanpää

The popularity of biogas as a form of renewable energy has increased at a great pace in Finland during the last decade. Pioneering small-scale innovations have over time grown into industrial operations and the demand for biogas as a replacement for fossil fuels has created a good basis for the emergence of new biogas operators. In the last few years, the digestate produced by biogas plants has started to find its place as a recycled nutrient product that can be used as a replacement for industrially manufactured fertilisers.

Honestly "bio"

When biogas is mentioned, people almost always have a preconceived idea about it. If nothing else, the prefix 'bio' is in one way or another connected to environmental friendliness and a subject that will in the future have a strong position when we move on to more sustainable energy solutions. Biogas might otherwise be a foreign concept to the uninitiated, but the things mentioned above are already a solid starting point, since biogas is truly environmentally friendly bioenergy. In order to promote conservation of the environment and standardise environmental licence policies within the EU, the planning of larger biogas plants must also take into account the BAT (Best Available Techniques) reference document defined for waste treatment. The best biogas plant processes, whether big or small, enable the production of environmentally friendly and sustainably produced local energy, as well as soil conditioner and recycled nutrients suitable for even the needs of organic production. When material that has gone through the digestion process is used as it is in fields or as processed into commercial fertiliser products, the product can safely be called ecological.

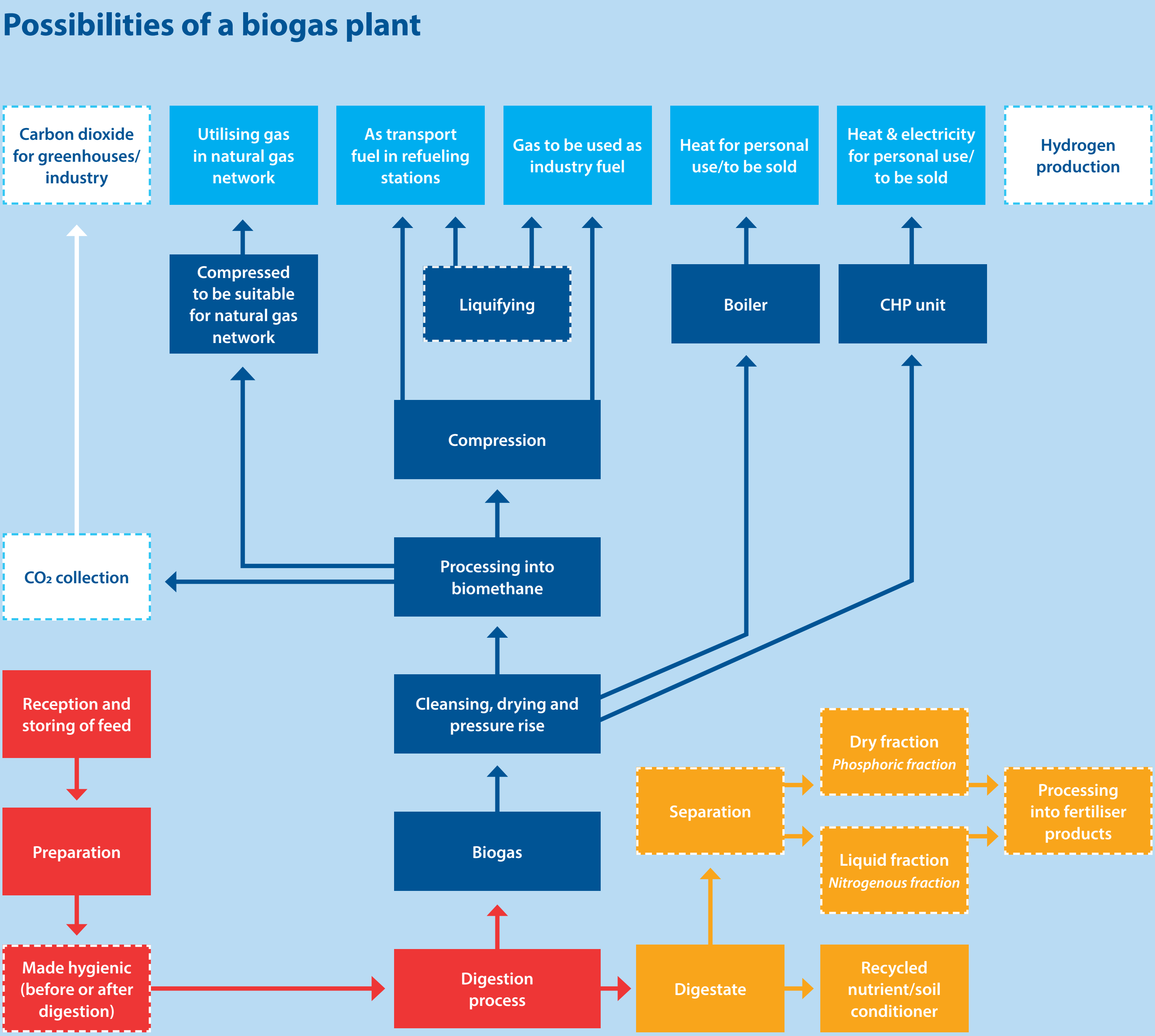
Raw materials appropriate for a biogas plant i.e. feed is created huge amounts in both nature and the society's operations. Household biowaste, sludge from sewage treatment plants, food industry by-products, agriculture manure and many other organic materials can be used as feed. In addition to digestion plants, biogas can be collected from landfills where biogas is formed in the depths of old landfill banks. In Finland, landfills gases are largely utilised, but elsewhere in the world landfill banks still contain a lot of energy production potential.

Biogas' role as a replacement for fossil fuels

At the moment, biogas is widely utilised in its gaseous form, either as crude gas with a methane content of about 60% or after being processed into biomethane with a methane content of about 98%. Lately, the liquifying of biogas has also gained a foothold in Finland, which is great. When we talk about just the traffic use of biogas, or more accurately biomethane, both gaseous and liquified forms have their users. In traffic, compressed biomethane (CBG) is mainly used by passenger cars and, for example, refuse trucks and buses. Liquified biomethane (LBG) on the other hand is better suited to powerful heavy vehicles and, on an even larger scale, marine traffic. When biomethane is liquified, larger amounts of it can be fit in a vehicle's fuel tank, which enables longer drives between refuelings. Heavy vehicles using liquified biomethane are already used to some degree in road transport and once the fueling network of liquified methane has been expanded, we can certainly expect traffic contractors to move on from using fossil fuels. There already is a reasonable amount of refueling stations for compressed biomethane in Finland, excluding the easternmost and northernmost parts of the country. Since the biogas market is still evolving, it must be said that natural gas still has its own role in traffic use.

Biogas and biomethane developed from it have, as a form of renewable energy, been well-received by industry. Industry aims for carbon neutrality and biogas can support this goal very well. Many industrial operators have replaced fossil fuels with renewable energy, with one option being switching to biogas. Having an industrial plant located within a reasonable distance from a biogas plant can at

▼ ***Figure 1.*** *Possibilities of a biogas plant.*



best create excellent solutions for the needs of both plants. The industrial plant can supply by-products to be used as raw material at the biogas plant and the biogas plant can supply gas or electricity and heat produced from gas for industrial needs. Therefore, an industrial plant does not need to be located close to a gas network in order to use biogas. There already are some off-grid biogas plants of industrial size that operate outside of gas distribution networks, and more are being planned. Cooperation between industry and biogas plants enables keeping the transport distances to areas outside the gas network reasonable. Additionally, utilisation of biogas supports the implementation of sector integration. When planning biogas plant investments, things such as end users of gas and their location and the availability of the plant's raw materials are also considered carefully. Elomatic has been part of several biogas plant projects in tasks such as producing feasibility surveys and planning the plant process. Elomatic's wide-ranging competence is visible in the charting of the optimal location for the plant project, estimating of investment costs and in the implementation stage of the project.

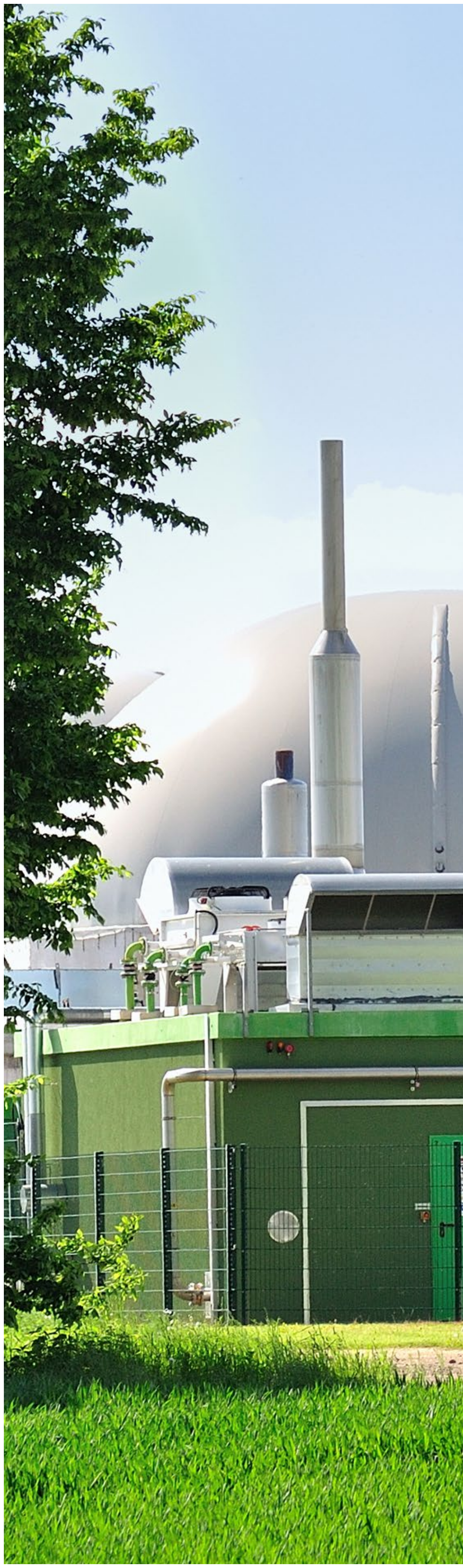
Finland has considerably more production potential of biogas than is currently being utilised. Realising that potential has posed a challenge for biogas experts for a long time and a huge amount of work has been done for it. The fact is that the operations of a biogas plant are business operations which are affected by political decisions and assistance forms and incentives that are build around the plant projects. Sure, on a smaller scale biogas can be produced for non-commercial use, for example, on a farm it can used to produce heat and/or electricity and to replace fossil fuels. But even in these cases the plant is required to produce some additional value for the operations of the farm. There are even household-specific biogas production devices in the world, but these devices are more likely to inspire a new hobby related to the production of renewable energy than actual financial benefits.

Even though the traffic use of biomethane will likely in the future be largely focused on heavy equipment, due to the high volume of fuel the equipment uses, passenger car traffic should not be forgotten. Unfortunately, the decision-makers in Europe have sent slightly concerning signals to car manufacturers in relation to emission standards, and the passenger cars using biomethane as their fuel are not at the top of the manufacturers' list of priorities. From the manufacturers' viewpoint this is understandable, since the vehicles manufactured must meet strict emission standards. However, we still hope that the decision-makers will rule that when it comes to emissions, the emissions created throughout a vehicle's entire lifecycle would be considered, not just the emissions created during use. In this way, the gas-fueled passenger cars could be kept on the market to create low-emission traffic. Here it is good to specify that the term 'gas-fueled vehicles' refers to gas-fueled vehicles equipped with a combustion engine, not vehicles that use hydrogen as their energy source.

"Finland has considerably more production potential of biogas than is currently being utilised."

Agriculture holds great potential for biogas production

On a European scale, Finland is still a small operator in the biogas industry, although there has been some growth. Growth potential can still be detected in the production of biogas, and the feed produced by agriculture in particular has a huge amount of



potential. Animal manure and, for example, previous year's fodder contain energy and utilising it should still be enhanced. Digesting the side streams of agriculture creates locally produced, renewable energy at its best. At the same time, methane, which would be released into the air as greenhouse gas as a result of spreading manure on farms, can be now collected. Another current focus point for development efforts is the further processing of the digestate produced by biogas plants. Thanks to further processing solutions, biogas plant operations could be made more profitable and the beneficiaries would include the environment and, of course, users of the final products. With processing, different nutrient products can be separated from the digestate and in this way, the nutrients can be focused on the areas where they are needed the most. In places where animal manure is created on a large scale, the soil's nutrient level is usually such that nutrients can be transported to other areas that have less nutrients. Performing further processing at a plant can decrease the storage and transport amounts of final products, which will further improve operations' profitability and the environmental load caused by transport. In the case of a biogas plant, the financially most sensible options must be considered, and pondering this often produces new and more sustainable innovations.

Biogas has its place in the future

The operations of biogas plants of the future will likely be a little different from those of today. At the moment, there are several projects ongoing around the topic of how the operations of biogas plants could be enhanced and what kinds of new components could be created around the operations. In addition to the further processing of the final products produced by biogas plants, the focus could also be directed at developing the collection of carbon dioxide and possibly producing hydrogen from biogas. Producing hydrogen from renewable raw materials is an interesting addition to energy production but here, too, new innovations are required in order to make the production as sensible as possible. Will larger-scale production be profitable with just crude gas or will it absolutely require processing biogas into biomethane? That remains to be seen. There is so much research being done that this matter will advance at a great pace in the next few years and biogas plant operators will likely have a key position in the development.

This year, we can also expect a decision on making biogas part of the national distribution obligation, which is hoped to promote the use of biogas as transport fuel. In April 2021, the Finnish Government submitted a government bill concerning the promotion of the traffic use of biofuels to Parliament. The implementation of this bill is currently expected. This will also make biogas taxable, despite which the benefits are still estimated

"Finally, it is good to remember the little fact that the effort of us all is needed in the sorting of biowaste in particular so that the organic waste of households is not incinerated with mixed waste."

to be adequate enough to increase traffic demand for biogas. Sustainably produced biogas is a very good part of energy production when the discussion is about decreasing carbon dioxide emissions in the near future. Biogas is an excellent form of energy for security of supply as well, because it can be produced locally from renewable raw materials and, therefore, it can be used to replace energy imported from abroad.

Finally, it is good to remember the little fact that the effort of us all is needed in the sorting of biowaste in particular so that the organic waste of households is not incinerated with mixed waste. Organic waste has poor value when incinerated, but it is an excellent raw material for a biogas plant's processes. In Finland, the sorting of biowaste is largely in order, but as long as material suitable for digestion process still ends up in mixed waste, there is room for improvement. Biogas will have its own foothold in the future and Elomatic wants to participate in the building of a cleaner future and help its clients implement carbon-neutral energy solutions.

About the author

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Anne has over 15 years of experience in project work. She has been working mainly on biogas and heat & power plant projects and therefore energy industry and environmental technology are very close to her heart. Anne also has experience in environmental permit application processes. Working as a designer as well as a project manager has learned plenty of valuable things related to project work. Anne joined Tampere Energy Consulting team in March 2021 as a project manager and process specialist.

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▼ ***Figure 2.*** *Project management, consultation and planning services*

Interaction with authorities

- Environmental permit applications
- Environmental impact assessment procedures
- Nature conservation permits
- Permit for hydraulic engineering
- Action permit solution applications
- Building permit
- Planning permission for minor construction
- Flight obstacle permit
- Emissions permit and emissions rights
- Industrial waste water agreement/ permit for directing waste water to sewage system
- Chemical permit, chemical declaration
- LPG permit, LPG declaration
- Pressure equipment support
- Electrical Safety Act
- Food Act
- Rescue Act
- Occupational Safety and Health Act

Safety

- Rescue plan
- Conformance
- Explosion protection document (Atex)
- Danger assessment (environment and occupational safety)
- Risk surveys
- Dangerous substances
- EHS matters, contact with stakeholders, negotiations with authorities
- Reporting
- Chemical safety
- Waste management plan
- Safety (occupational safety in planning, site safety, declarations)
- Industrial safety

Quality

- Inspections of implementation and plans made

Looking for a silver bullet, or, how to make the world carbon neutral by 2050?

Text: Teemu Turunen

The European Union, the United Kingdom, Japan, South Korea and over 110 other countries have committed to becoming carbon neutral by 2050 and China has set the same goal for 2060 [1]. The United States will, according to the recently published goal, cut their emission from the 2005 level by 50–52 per cent by 2030. How realistic are these goals and which measures are being taken to achieve them?

What did the world of energy look like in 1953 and 2018?

The conversation about our society's efforts towards a carbon neutral future has accelerated and different countries have published their goals for this transition. Roadmaps and lists of measures on how to concretely implement the change are currently being drafted. When defining the measures, it is important to examine both the change's realistic schedule and impact in relation to the goal. One way to see the future is to base the scenarios partly on history and the current situation.

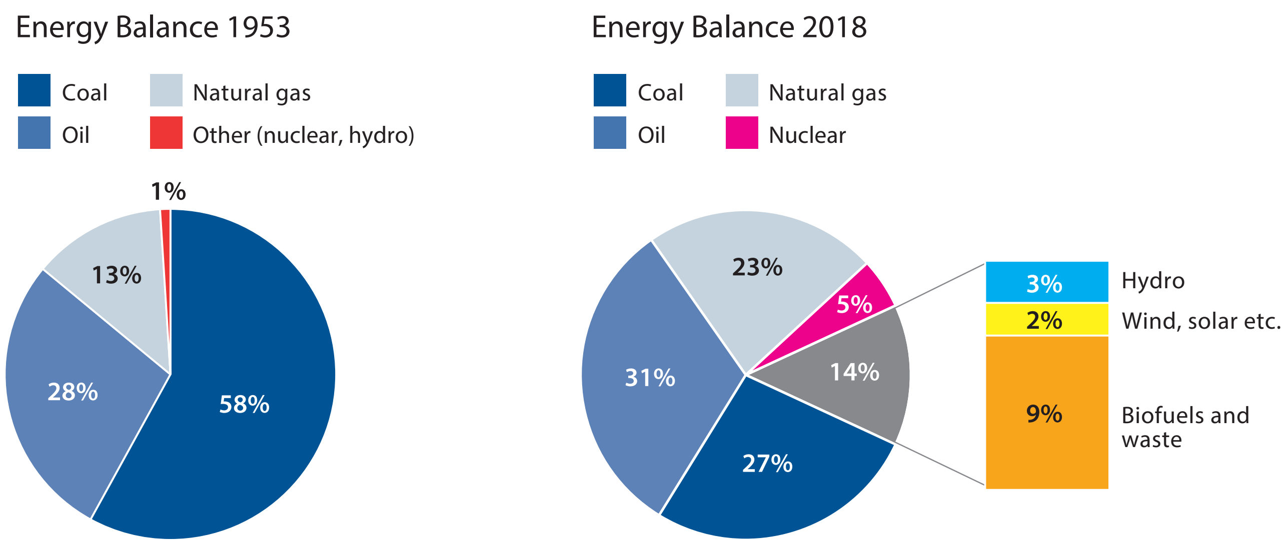
When we examine energy production in the 1950s **(Figure 1)** we can see that it was based almost entirely on fossil fuels. Correspondingly, when we examine the numbers from 2018, we notice that in 65 years, carbon's share of the world's energy production has decreased by almost a half, but on the other hand, oil's share has remained almost the same. Correspondingly, the share of natural gas has significantly increased while renewable forms of energy have increased to be one seventh of overall energy.

The speed of the energy transition must be accelerated if we want to achieve an almost carbon-neutral world within the next 30 years. When we examine the reasons for the slow change, at least two factors become noticeable; energy's cheap historical price and climate awareness only becoming widespread in the last decade. The low price of fossil energy has kept it in a central role in energy production while also slowing down the implementation of new technology. Wind- and solar-based energy production has only recently started to grow significantly, boosted by both public policy instruments and the development of technology. Policy instruments will continue to have a key role in the energy transition in future. On the other hand, climate awareness has improved in the 2000s. Its most notable messengers include Al Gore with his documentary An Inconvenient Truth and Greta Thunberg with her campaign Skolstrejk för kilmatet. Gradually, a growing number of countries are committing to climate goals.

How to keep moving forward, what are concrete measures for the next thirty years? We have numerous methods, and all the technology needed for the change is already available to us. The measures needed can be roughly divided into the following main categories:

1. Moving on from fossil fuels
2. Energy efficiency for different areas of society
3. Carbon dioxide absorption and utilisation as long-term tools

Next, we will examine these solutions in more detail.



▲ ***Figure 1.*** *The world's energy balance in 1953 and 2018 [2, 3]*

Moving on from fossil fuels

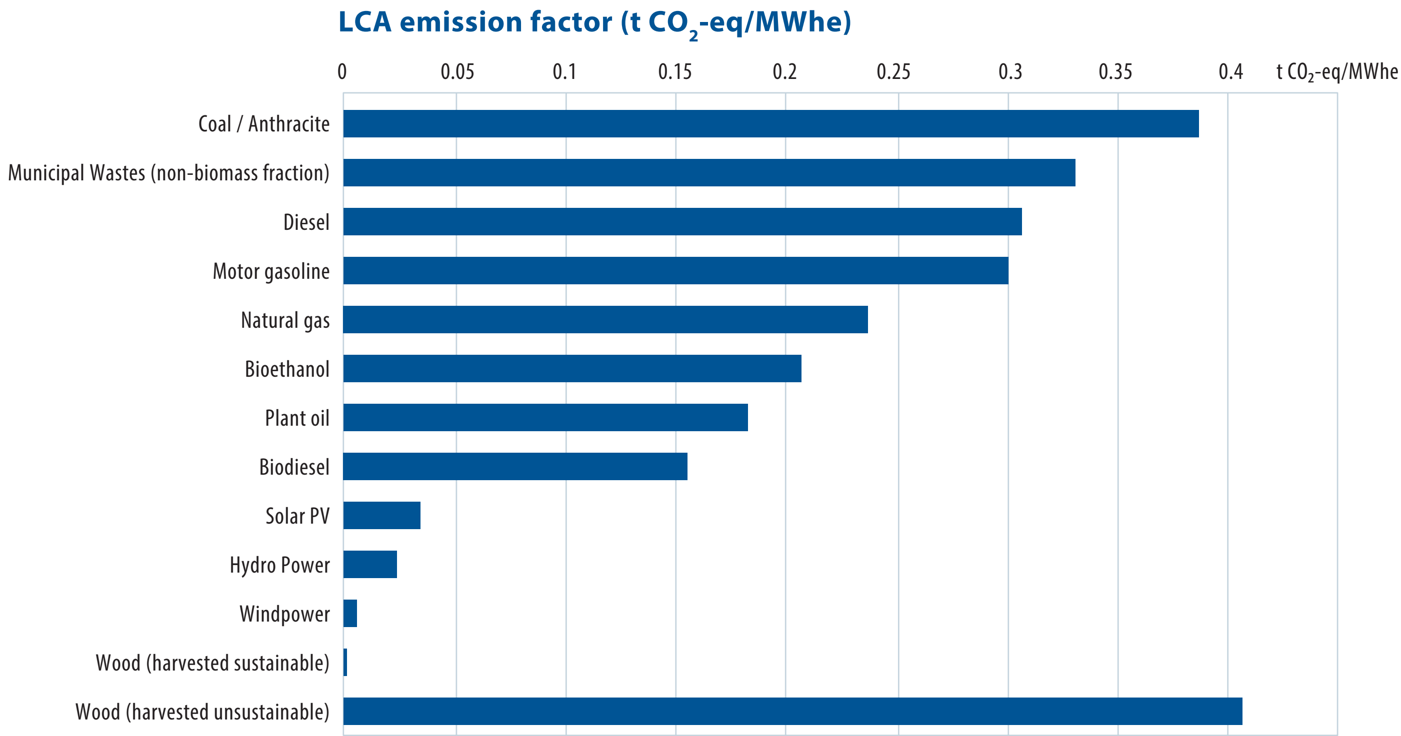
As presented above, it is obvious that we must give fossil fuels up in a controlled manner. In practice this means that there is no individual energy solution available that could replace all fossil-based energy sources. The overall solution must be formed from several different operators and technologies. When we compare different measures, we must take the entire lifecycle into account in order to ensure that the results are comparable. **Figure 2** presents producing electricity in different ways and examines the CO_2 emissions produced throughout the lifecycle (LCA).

From the figure we can see that production forms based on sunlight, wind and water distinguish themselves. A noteworthy matter is the surprisingly large environmental impact of biofuels, when the entire lifecycle is considered in the examination. Another noteworthy matter in the figure is the significant range of wood (the wood has been calculated a higher value in situations in which the harvesting has not been performed sustainably), which is likely to set preconditions for growing and utilising forests. Either way, it is clear that different forms of production will also be needed in the future and their sustainability must be developed.

Lately, the public conversation has revolved around the EU's taxonomy proposal in which the objective is to develop a system of classification for environmentally friendly investments. The classification is used to promote the implementation of sustainable investments and the European Green Deal by providing companies, investors and political decision-makers with appropriate definitions so that they can focus investments on sustainable solutions. This system will probably affect the financing available to energy production investments and guide them towards more sustainable forms of production [5].

One of the tools for the journey towards clean energy production is sector integration. At its best, it is a cost-efficient way of utilising the characteristics (especially flexibility) of different sectors so that the share of renewable energy used in the system can be maximised while also ensuring the security of supply [6]. Advancing electrification is also seen as a tool for achieving carbon neutrality. Increasing the share of renewable energy enables companies to move on from fossil fuels, but on the other hand, it will create variation in our energy system. This in turn will also create new business opportunities for different operators. In practice, the advancing electrification can be divided into the three following areas:

- Direct electrification by, for example, producing heat with electric boilers or replacing a process device that uses natural gas with one that uses electricity
- Electrification with heat pumps, which enables utilisation of lost heat and production of added value with a smaller amount of electric power
- Hydrogen production with renewable energy and utilising it both directly and in the manufacturing of synfuels



▲ ***Figure 2.*** *Lifecycle CO_2 emissions of different electricity production methods [4]*

Energy efficiency measures for different areas of society

Energy efficiency is not a new thing; it has been discussed since the energy crisis of the 1970s, first as avoiding the wasting of energy, then as saving energy, and in the last decade it has come to mean energy efficiency. In future, it will be seen as one of the most cost-effective solutions for combatting climate change. It has been estimated that in Europe it could be possible to save 150–220 Twh a year by investing in energy-efficient solutions and, for example, new CHP technology [7]. The EU has set the goal of increasing energy efficiency by 32.5% by 2030 [8]. A noteworthy aspect of improving energy efficiency is that technologies that improve industry's energy efficiency are mainly well known and there is no need to develop new technology in a major way. It is essential to implement new technology and expand the concepts that have been proved to be good and economical over the borders of industrial sectors [9].

"In future, energy efficiency will be seen as one of the most cost-effective solutions for combatting climate change."

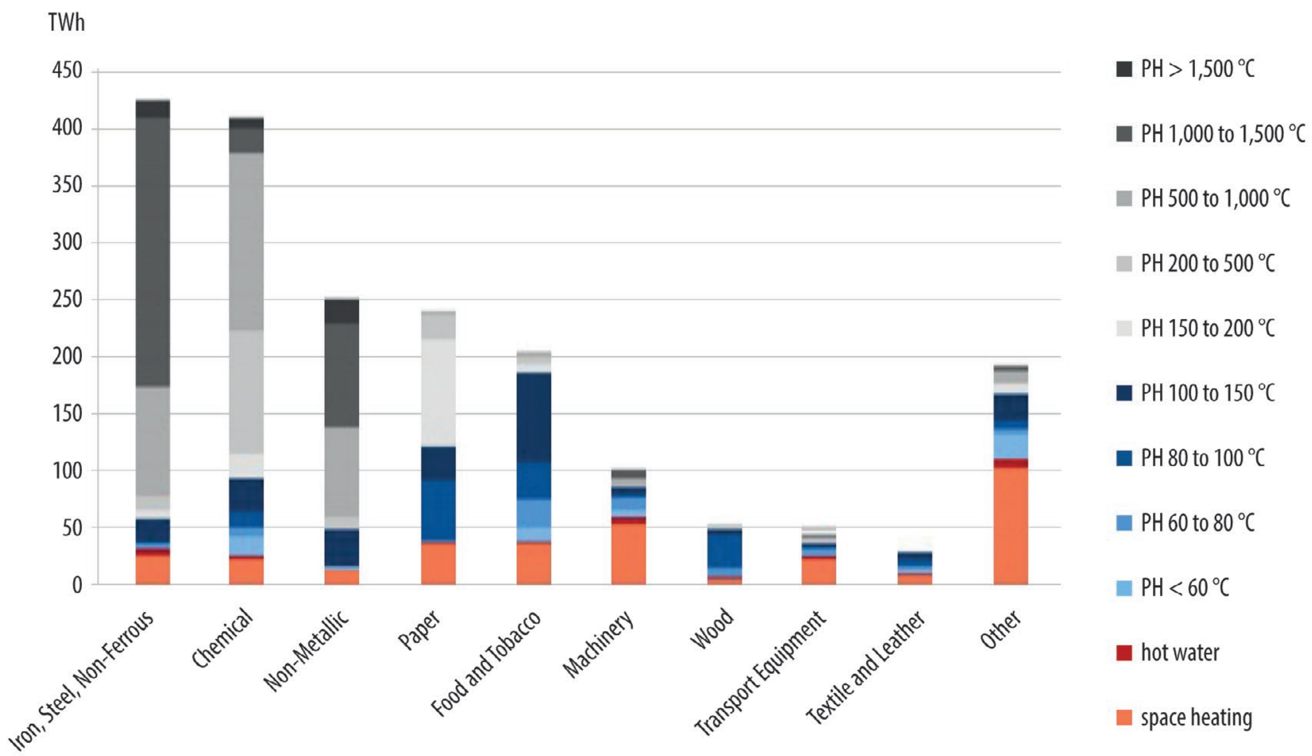
One concrete measure for promoting energy efficiency is to use heat pumps in industrial sectors. When we examine different industrial sectors' heat use and temperature levels in Europe, we see that the utilisation opportunities for heat pumps vary from sector to sector **(Figure 3).** It has been estimated that the technical potential for industrial heat pumps could be (in the EU 28 area) as much as 1,717 PJ (477 Twh), of which about 270 (75 Twh) could currently be realised as financial potential [10].

In future, thanks to the development of the heat pump technology, increasingly higher temperature levels can be reached, which will create new utilisation opportunities for them. The objective is to utilise heat pumps increasingly deeper in the processes and in increasingly complicated application sites, which will give utilising them together with different stored heats a significant role. This will promote the electrification mentioned above as part of energy production.

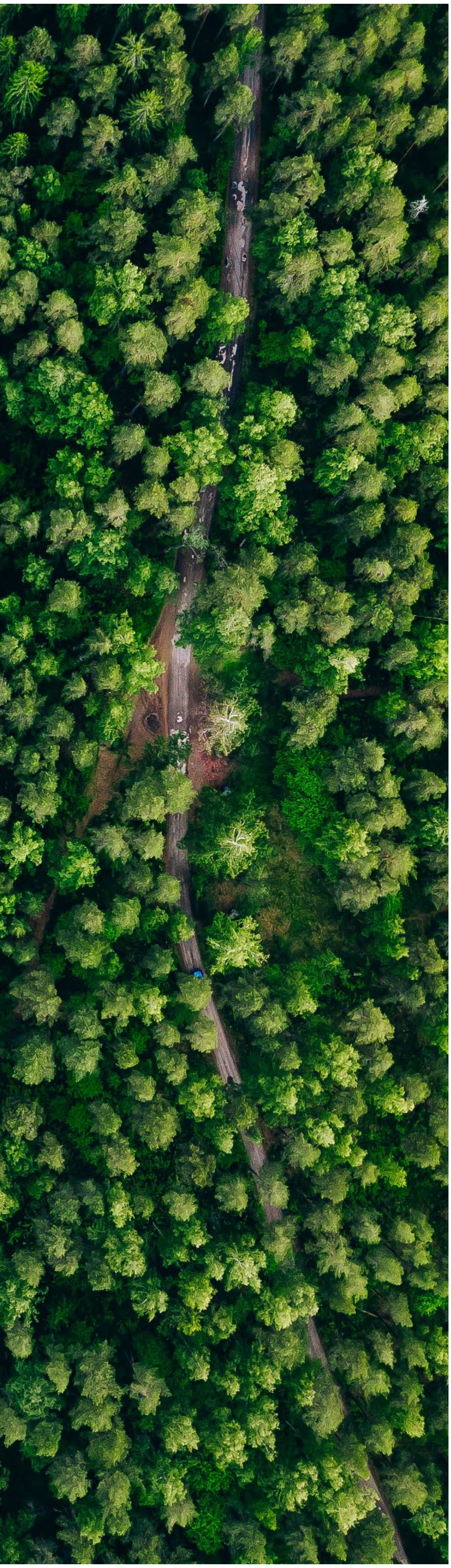
Carbon absorption could help us reach carbon negativity

Carbon negativity refers to a product's, company's, municipality's or country's net effect that removes carbon from the atmosphere, which then prevents or slows down climate change. In practice this means using a method to absorb more carbon than gets released into the atmosphere. The methods for implementing this in practice are being developed and examples of the technologies are the following [11, 12]:

- The CCS technology, in which carbon dioxide created from incineration is collected and stored



▲ ***Figure 3.*** *Temperature levels and energy amounts utilised by different industrial sectors [10]*



in the earth's crust. If it is about collecting from incineration of biomass, the term is BECCS technology
- The CCU technology, or, collection and utilisation of carbon dioxide. This technology utilises the 'power to fuel' method, in which carbon-neutral fuels, such as synthetic gas, methanol, or Fischer-Tropsch products, are produced
- Collecting carbon dioxide directly from the air and utilising it in the CCS and CCU solitions
- Afforestation and taking care of existing carbon sinks are tools used in absorption of carbon. Sustainable forestry is an essential part of this
- Absorbing carbon with products, such as biochar which can be used as a soil conditioner, for example.

Carbon absorption will become a major tool after 2050, but the first commercially profitable projects will likely be seen as soon as in the 2030s. Carbon dioxide may not be collected in the utilisation of first-phase P2X technologies, but these projects will pave they way for the development of technology for full-scale CCU. Overall, the developing hydrogen economy will be connected to the absorption and utilisation of carbon in the future. Hydrogen technology will also be connected to a wide variety of technologies and application sites and it will have a significant role in both the electrification of the society and the replacing of fossil fuels.

Energy transition is an opportunity, especially for suppliers of clean energy

Carbon-neutrality goals also create entirely new business opportunities for technology suppliers, energy companies and industry. The carbon handprint enables new exports opportunities for suppliers of clean technology. The carbon handprint refers to how much one's own actions help others decrease their emissions. In this way, a pioneering operator can both grown its carbon handprint and benefit when selling its solutions to others [13].

A good example of the carbon handprint and carbon absorption is replacing glass wool with a wood-based solution. The provider of a wood-based solution can affect its customer's carbon footprint and, at the same time, the product absorbs carbon for a long time **(Figure 4)**.

For energy companies, the energy transition brings with it the challenge

▼ ***Figure 4.*** *Carbon dioxide emissions of glass wool and a wood-based solution [14]*

Glass wool	
CO_2e g/kg	3148
CO_2 fossil g/kg	2909
CH_4 g/kg	7.7
N_2O g/kg	0.16
CO_2 uptake g/kg	0
NOTE: Unit weight: 10–100 kg/m^3 (External walls with wooden supports 22 kg/m^3, wall panels for partition walls 14 kg/m^3, insulation of partition walls 100 kg/m^3).	

Wooden fiber insulation	
CO_2e g/kg	243
CO_2 fossil g/kg	—
CH_4 g/kg	—
N_2O g/kg	—
CO_2 uptake g/kg	1240
NOTE: Unit weight: 26–65 kg/m^3.	

"It is also essential to change the way people think so that the energy transition can be seen as an opportunity in which the anticipatory and active operators can be the winners of the transition time"

of adjusting the company's main business, but it can also be an opportunity to reform and develop the operations. Many energy companies have boldly started to offer different services, such as recharging points for electric cars, district cooling, solutions of distributed energy, circular economy services, etc. In the future, it will also be possible to provide customers with the same amount of energy, even with smaller investments, which will in part lessen the risks related to core business.

Different industrial sectors are at different stages in their carbon-neutrality efforts, but for industrial companies that operate very efficiently and environmentally friendly the carbon-neutrality targets can become a competitive edge in the future. However, investments in low-carbon energy production, the circular economy and energy efficiency will still be needed.

Summary

As we can see, there is no individual silver bullet that could be used to combat climate change and ensure a carbon-neutral future. Many different, strongly interconnected solutions of different levels are needed. Therefore, it becomes important that each operator chooses the most impactful and efficient measures that best suit its operations. It is also essential to change the way people think so that the energy transition can be seen as an opportunity in which the anticipatory and active operators can be the winners of the transition time. Co-operation between different operators will also be central so that resources and competences can be efficiently focused for the common cause.

Source

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Hydrogen Fuel in Maritime Use

Text: Mika Vuorinen

The introduction of renewable energy is a major step to improve the local and global environment and bring down costs universally around all industries. The pursuit of green energy has caused a tidal wave of technologies to sprout with the aim of improved energy economy and utilization of low-emission energy carriers. The IMO 2050 strategy to reduce emissions is one driver towards lowered emissions in the maritime field and with innovative solutions introduced towards reaching this goal, there will be economical benefits in it in the long run. Though it is good to consider a variety of proposed alternative fuels that are increasing their foothold in the industry, a simpler path to the whole story can be found from the opposite end considering well-to-wake efficiency and emissions of a ship.

Well-to-wheels means an analysis of the whole fuel supply chain and is often a reference to fossil fuels but can as well be a reference to alternative fuels, energy carriers derived from either carbon-based or fully renewable sources. The maritime take on this, well-to-wake analysis, consists of extraction of the fuel, possible refining of the fuel, transportation and bunkering, and finally energy conversion to electrical or mechanical energy to power a vessel, thus producing a wake. Coming back from the wake, energy production for a vessel is the first place to increase the efficiency of the whole supply chain.

Application

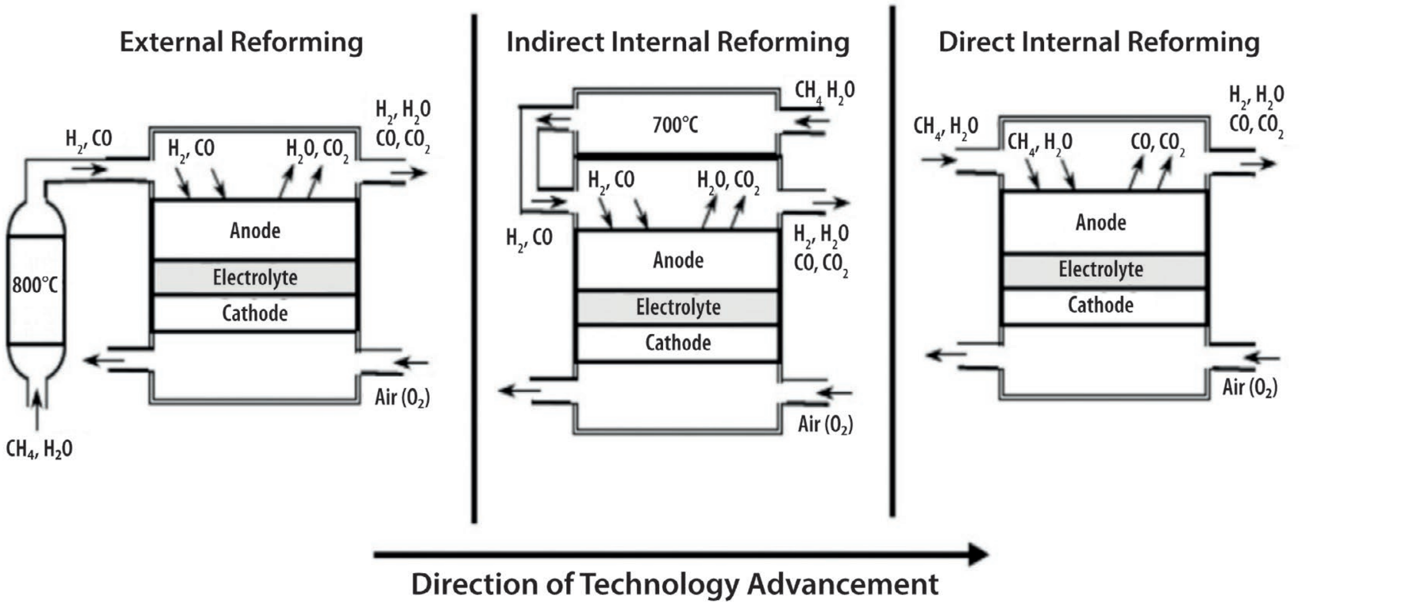
Applications for higher fuel efficiency onboard a vessel can be reached by introducing new technology or by improving the existing equipment. In a general situation, fuel efficiency on a newbuilt ship is a sum of power production and transmission. Without going into too much detail, power production is the main engine and power is transferred as mechanical, heat and electric power. For fuel efficiency, the popular solution – from internal combustion engine to mechanical power and with a generator to electric power – can be increased up to 50% but in practice is around 45%. Efficiency can be increased with additional equipment, for example a waste heat recovery system can increase the fuel efficiency of existing systems by roughly 10%. An internal combustion engine can be optimized for alternative and gaseous fuels, reaching similar fuel efficiencies.

Another fuel-based technology utilizing chemical energy is fuel cells, which convert the fuel gas directly into electricity and enable very high electrical efficiency. Different types of fuel cells allow high electrical efficiency, currently up to 60%, and are well suited in a maritime environment due

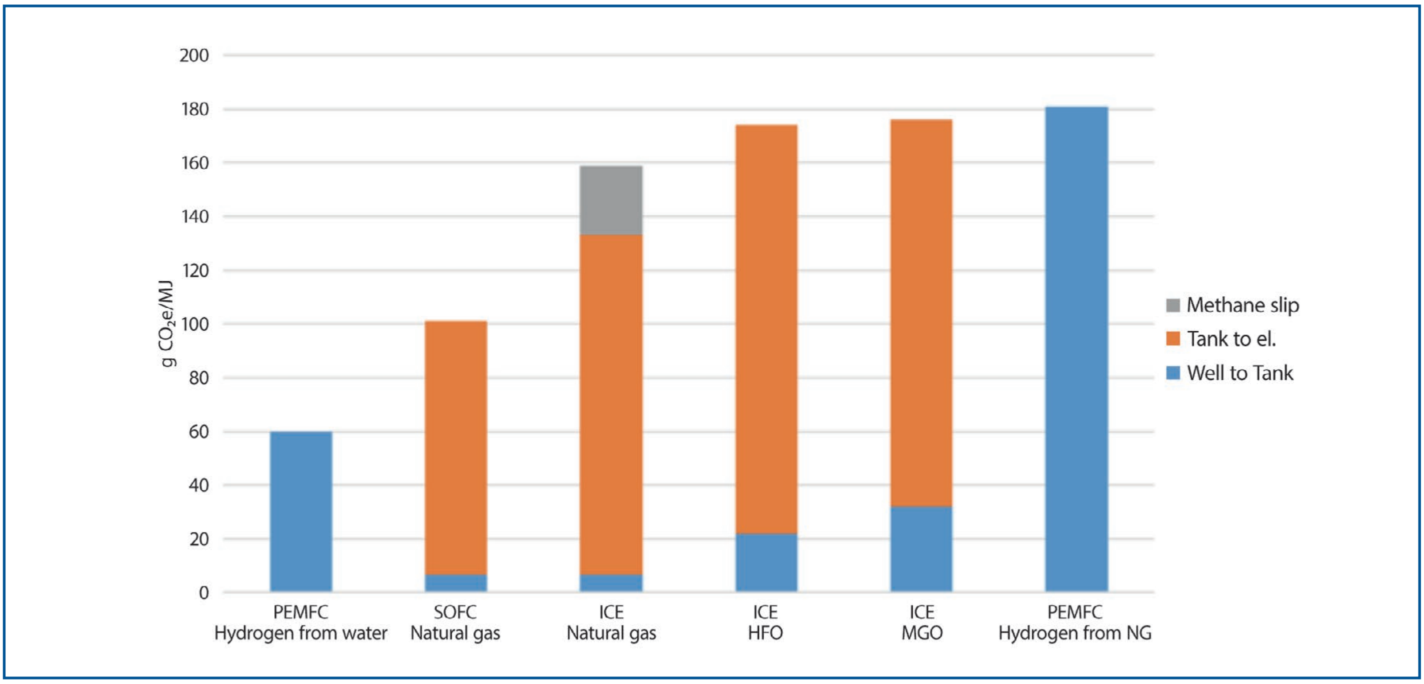
to their good part load characteristics and minimum vibration and noise emissions. Fuel cells allow the possibility to reach reduced maintenance, modular and flexible design and water generation. The most attractive fuel cells for maritime use are PEMFC (polymer electrolyte membrane fuel cell) with high energy density and some maturity in the field, and SOFC (solid oxide fuel cell) with high temperature and even higher efficiency capabilities.

PEMFC has maturity in the maritime field as a trial fuel cell, resulting in good initial outcomes for the system and has led to more comprehensive testing. The PEMFC system is very simple, and due to its low operating temperature of 70 °C, the maintenance cost is low. The latest modules have a size of up to 200 kW while being physically small, with 55% fuel efficiency. PEMFC will require highly pure hydrogen fuel onboard, which will demand a hydrogen storage or onboard system for reforming purified oxygen. PEMFC uses an expensive and trademarked Nafion membrane, which does not endure higher operating temperatures. A lot of research is being concentrated in the development of high temperature PEMFC, which would overcome the high purity hydrogen demand and allow more flexible fuel utilization.

The SOFC system is a moderately sized fuel cell, capable of highly efficient energy generation from hydrogen, natural gas and renewable fuels with reduced emissions in comparison to internal combustion engines. The system requires high temperatures, 700 °C, to operate and can reach 60% fuel efficiency with a 60 kW unit. The current SOFC system's major weaknesses are load cycling, a large and complex system and immaturity of the technology, but its fuel flexibility and efficiency encourage further development for the system. The SOFC system does not require reforming the unit to utilize light hydrocarbon fuels, such as methane and propane, or ammonia, but can utilize them as is. The high temperature in ship use allows combined heat and power use further increasing the fuel efficiency. Oxygen for both fuel cells is available from ambient air.



▲ ***Figure 1.*** *Fuel cell configurations, internal reforming systems requiring a high operating temperature fuel cell.*



▲ ***Figure 2.*** *Well-to-wake emissions of fuel alternatives in shipping.*

Maritime fuels

Maritime fuels can be divided into residual oils, or heavy fuel oils (HFO), and distillate oils with lower sulfur content (MGO, MDO). Low flashpoint fuels or more commonly alternative fuels are: Natural Gas (LNG), Ethane, LPG, Dimethyl Ether (DME), Methanol, Ethanol, Hydrogen, Ammonia. These fuels have relatively low greenhouse gas emissions and zero SO_X emissions. In pursuing the lowest well-to-wake emissions, the production of a fuel, if not occurring in the nature, has a major effect on the supply chain emissions even if the operative emissions were to stay low.

Most alternative fuels are produced from hydrocarbons, but some have synthetization methods chemically (ammonia, DME utilizing hydrogen) or electrochemically (hydrogen through electrolysis). The debate about the most promising fuel for shipping purposes is intense and criticism toward all is a good habit to maintain. One thing to keep in mind is that the further processed a fuel is, the more efficiency is lost and well-to-wake emissions increase. For this article and its limited space it is good to concentrate carefully and not to get further carried away, and to minimize both operative and production emissions; hydrogen with the potential for zero CO_2 emissions will be chosen as the target of examination.

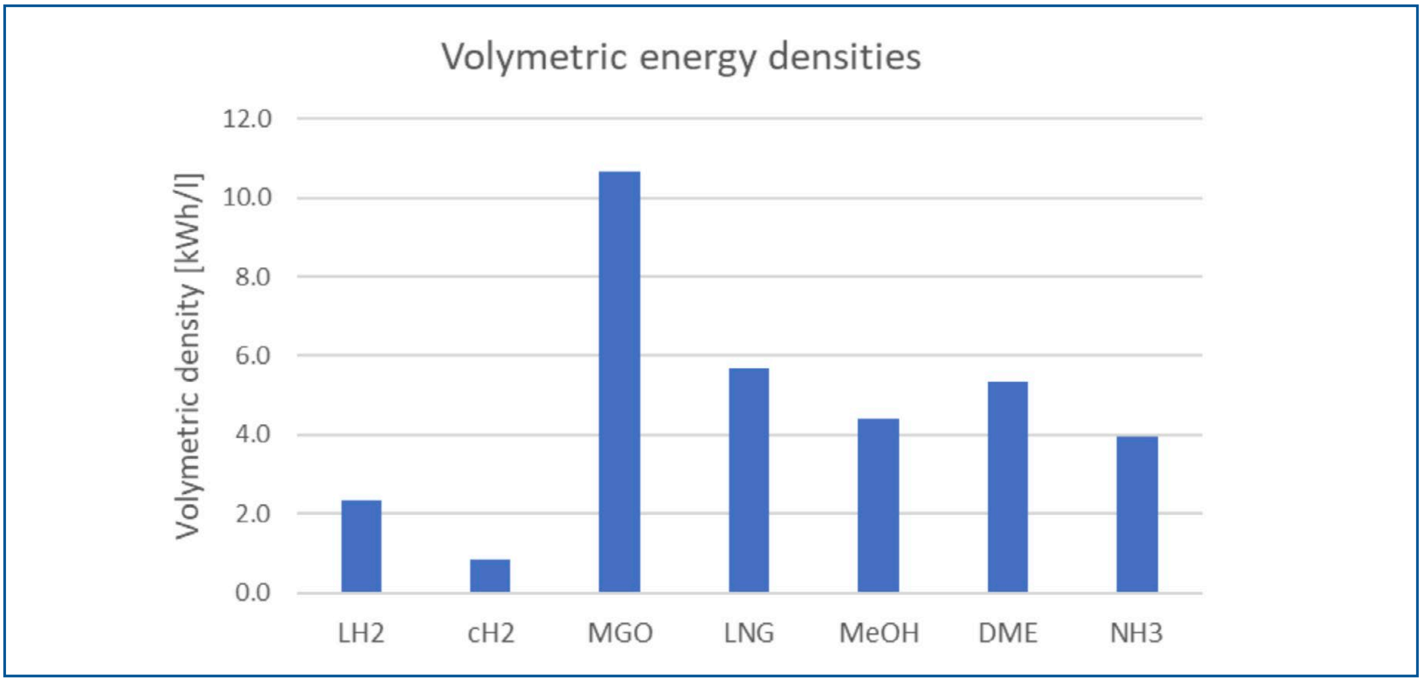
Hydrogen does not appear isolated in nature. Hydrogen is generated in several different methods, most commonly by reforming hydrocarbons (natural gas) or by electrolysis through water. The origin of hydrogen can be referred to as the hydrogen rainbow, where different colors describe a variety of possible production methods. The important ones are: grey hydrogen, which is produced from natural gas mainly by steam reforming; blue hydrogen is the same as grey, but the CO_2 is captured or re-used instead of released into the atmosphere; green hydrogen, which is produced with zero-carbon energy sources through electrolysis.

In 2020, the majority of hydrogen produced was grey hydrogen by 95% of all produced hydrogen. Hydrogen produced from natural gas needs three steps to reach the industrial standard of pure hydrogen, requiring, besides steam reforming, also steps through water gas shift and pressure swing adsorption, which are part of a standard hydrogen plant. This process reaches hydrogen purity for a PEM fuel cell. Hydrogen production with electrolysis is a method where water is breaking down molecularly to separate hydrogen and oxygen. Emissions of hydrogen production with electrolysis are tied to the used electricity.

Well-to-wake emissions for analysis include natural gas recovery, transportation, refinement, storage and bunkering. As combined in **Figure 2**, the production method for hydrogen from natural gas results in well-to-wake greenhouse gas emissions even larger than MGO and HFO when utilized in a modern four-stroke engine. The emissions from electricity used as a reference is the average Finnish electricity grid in 2020. With excess green electricity, the emissions for hydrogen production can be brought down to far lower emissions.

Hydrogen (in maritime business)

Hydrogen in maritime business brings potential for green energy but there are challenges in its utilization. As a low flashpoint fuel, risk of fire must be minimized and double-walled piping in a dedicated, well-ventilated trunk should be included. Even with heavy precautions with the fuel, it has been



▲ ***Figure 3****. Volumetric energy densities of maritime fuels.*

concluded that small hydrogen leaks are often overshadowed by the presence of air currents from ventilation, where the currents serve to disperse leaked hydrogen quickly reducing any associated fire hazard greatly. Storing hydrogen on the upper deck lowers the risk of fire in case of a leakage, as any leaking hydrogen rapidly moves up and away from potential ignition sources due to its light weight. On a ship, hydrogen storage must be well-ventilated and controlled with dedicated leak detection equipment.

The major challenge for hydrogen as a bunker fuel is the energy density. While having a high energy density by weight, hydrogen has very poor energy density by volume, forcing the bunker fuel to be either compressed up to 700 bar or liquefied. Liquefied hydrogen is stored at a low temperature of -253 °C. The liquefaction process efficiency is about 70%, while compressed hydrogen can reach 90%. **Figure 3** shows storage density of hydrogen as liquefied hydrogen LH_2 and compressed hydrogen cH_2 of 450 bar with other alternative maritime fuels.

Hydrogen storage is a challenging matter due to the size of hydrogen molecules, which are tiny and can diffuse through many materials considered airtight or impermeable to other gases. The diffusion rate of hydrogen increases with the tank pressure, close to 500 bar the rate nears 1% of cH_2 per day. There are challenges with LH_2 at bunkering and insulation due to its extreme temperature, and with poor liquefaction efficiency the compressed option is often more a viable option especially in smaller units in decentralized production, as pressurization for cH_2 is simpler and more efficient than liquefaction.

Summary

Overall efficiency in shipping can be improved and emissions reduced considerably, but this process must be done carefully considering many angles. Operative emissions can be brought down with different fuel options, but well-to-wake emission and efficiency should be considered, and green alternatives prioritized in the production of alternative fuels. Further study about which fuels and power production to utilize in different shipping situations from ferries to container vessels is to be expected, as a comprehensive solution to improve shipping is not yet in sight.

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Mika's background is naval architecture from University studies and has 2 years of experience in project work. His thesis covers hydrogen economy and fuel cells in maritime industry and has been working with energy and machinery solutions for ship conceptual projects with implication of industry standard and novel technologies. Mika has also experience in ship general arrangement and port operations. He has worked as part of marine Life Cycle solutions unit in Espoo since 2019.

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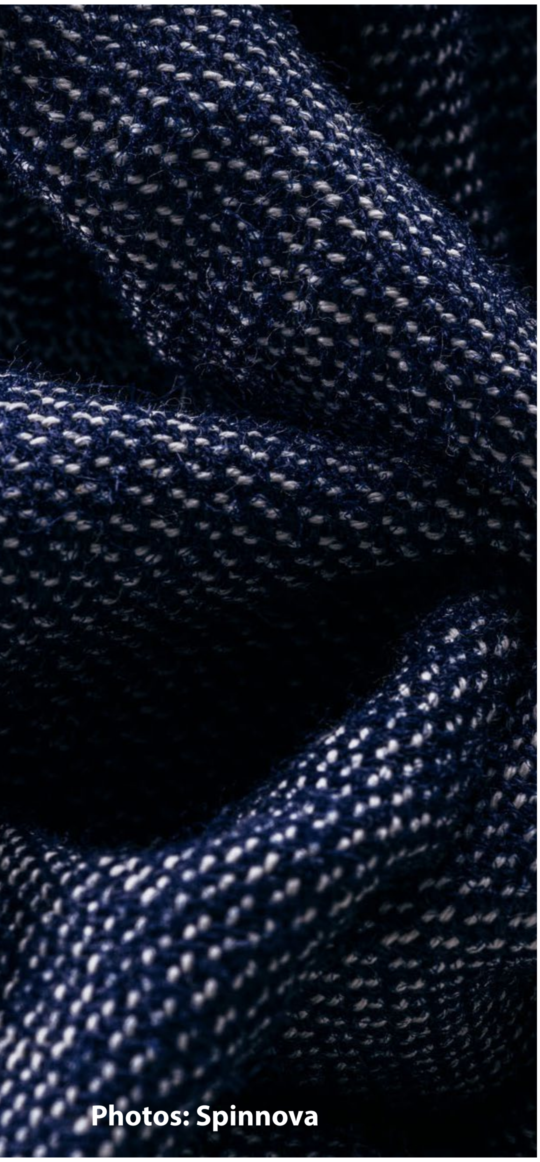
One’s waste is another’s resource

Text: Heikki Pirilä, Mari Vasara, Tiia-Maaria Ketola



Photos: Spinnova

Our economy is based on disposable goods and fossil energy sources, but new methods are constantly evolving. The ideals of circular economy is that there is basically no waste – only repurposed materials and active cross-industrial use of branch currents. Here we investigate zero-emission fuels and game-changing fiber technologies in which Elomatic has played a pioneering role.

Sustainability suits you

According to the European Parliament, clothing accounts for between 2% and 10% of the environmental impact of EU consumption. In addition, cotton cultivation takes up a lot of arable land and consumes immense amounts of water.

From 2025 onwards, an EU directive requires that all end-of-life textiles from consumers must be separately collected. As it currently stands, the majority of textile waste is thrown away, and the dimensions are huge – over 70 million kilograms of unused material every year in Finland alone.

Thanks to new technologies, most of that resource could be used to form new virgin fibers. Elomatic has partnered in a ground-breaking Finnish innovation, Infinited Fiber technology, that takes cellulose-rich waste that would otherwise be landfilled or burned – old textiles, used cardboard, crop residues like rice or wheat straw, and more – and transforms them into premium-quality superfibers for the textile industry. In addition, polyester residues are removed from the cotton material using methods like those of the pulp industry.

Licensing Infinited Fiber’s carbamate technology would allow it to be used in converting existing capacities, such as viscose factories, to be more environmentally friendly. With the technology, factories could produce fiber without carbon disulfide CS2 – a challenging, hazardous, and un-ecological chemical in the fashion industry value chain.

Another visionary invention is pioneered by Spinnova, for whom Elomatic designed a pilot plant. The start-up, based in the city of Jyväskylä, uses wood-based materials to mechanically produce textile fibers. Softwood pulp is transformed into a wool-like material without any chemicals and with only 1% water usage in stark contrast to the production of cotton fibers. Spinnova’s fiber has already been trialed by the Finnish design house Marimekko and the Norwegian outdoor manufacturer Bergans.

Fueling the new world

Could we finally approach the breakthrough of hydrogen vehicles? When produced by renewable energy, hydrogen technology could enable fueling our transportation with zero carbon. Hydrogen as an energy source has been known for hundreds of years, but high costs and challenges in storage hinder its progress.

However, in the Power2AX project by the Finnish project developer and investor Flexens, Elomatic studied different scenarios to produce hydrogen to be used in new ferries in the Åland archipelago. The approach includes harvesting wind energy, creating hydrogen fuel with the generated wind energy, and finally using the renewable fuel in ferries.

The archipelago has ideal wind conditions – in addition to being a suitable environment for revolutionary green technologies as one of the most beautiful locations of the world.

Power2AX is a textbook case of a new technology that has immense potential but needs funding and subsidization to fulfil its potential. Excitingly, Flexens has applied for EU funding and project realization is expected to start in 2024.

Let's start the cultural change

Pioneering technologies often get stuck in a chicken-and-egg situation of supply and demand: at small volumes they can be expensive to produce, which makes them less appealing for clients, but if investments would flow in then the production costs would decrease.

Changes in methods and ways of thinking always take time, but as history shows, distant visions may become everyday practice as soon as they are simple and cost-efficient enough. Elomatic can play a major role in transforming our clients' businesses or allowing them to take a leap to environmentally friendly materials or processes.

It is inevitable that legislation and consumer demands will continue to change for the good toward circular economy, and with that, material efficiency becomes a competitive edge. Even more so than before, we must take these principles into account right from the planning phase. How can we overcome unsustainable processes? What materials shall we use? How do we repurpose them?

As transition from disposable goods and fossil energy sources is accelerating, now is the moment to stay ahead of curve and help our clients produce the materials of tomorrow.

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Heikki's special competences are project selling and execution duties in process industry. During his career he has participated in more than fifty various types of geenfield and rebuild industrial projects, both domestic and foreign, such as turn-key, EPCM and engineering projects including also project management and procurement tasks. Heikki is an excellent team player and his willingness to travel has gained him noticeable international work experience.

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Mari Vasara has more than 15 years of experience in the paper and chemical industry. She has worked as a process development engineer, laboratory engineer and process designer, gaining deep knowledge of the paper industry applications as well as extensive knowledge of unit operations in the process industry. She also has strong experience in laboratory analytics, especially on the biofuels side. Mari has worked in the Plant group of Elomatic's Jyväskylä office for 3.5 years.

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Tiia-Maaria Ketola has worked as a Consulting Engineer at Elomatic for more than a year and a half, working on various pharmaceutical-, energy- and process design projects. She is a qualified material reviewer as well as Tiia-Maaria has performed demanding process chemistry simulations. In addition, she has more than ten years of work experience in researcher- / research- and development work both in Finland and abroad in research institutes, universities and industrial companies. Her area of expertise is chemistry and especially physical chemistry.

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Challenges in renewables scaling

Text: Pasi Leimu

Dealing with labile biological materials is challenging. Even more challenging is scaling them to industrial-scale production. The secret of success in scale-up is step-wise development of the processing concept in cooperation with the client and project management focusing on techno-economic feasibility – the target is maximal yield for minimal costs and time.

In bioengineering, useful metabolic products are produced from biological material in aseptic or even sterile conditions. In the wider concept of bio and circular economy, the production utilises naturally occurring renewable materials or recyclable materials in the form of waste or sidestreams of another operator and develops new innovative products with suitable technologies.

Engineers must have experience of multiple materials – from virgin fibre used in the forest industry to recyclable textile fibre and waste fractions of different origins. Also utilisation of sidestreams of food production, e.g., bakeries, meat production or dairies, such as whey, is targeted while not forgetting shelf life and traceability.

Understanding fundamentals

The challenges in today's biotech and aseptic process field are finding suitably scaled technological solutions to produce homogenous and uniform products. Usually, the trials are carried out first at the laboratory scale and then the pilot scale before the industrial-level process is reasonable and justified.

The labile biological materials make the fermentation and recovery processes a harder challenge than with chemical recovery. In these cases, the engineering is only an aid to regulation of biological processes and the micro-organisms command the centre of attention.

A clear understanding of microbial growth kinetics is necessary if a large-scale process is to be properly managed. Growth kinetics is treated differently for conventional batch processes than for continuous processes.

Although several fermentations for metabolite production work well as processes at a laboratory scale, only a few processes have proved useful for practical application due to clearly fewer operational hours to be stable in a laboratory than in an industrial set up.

Also, attention should be paid to maintaining hygienic conditions on an industrial scale over a long period of time. Variation of industrial composition of substrates has to be anticipated as well.

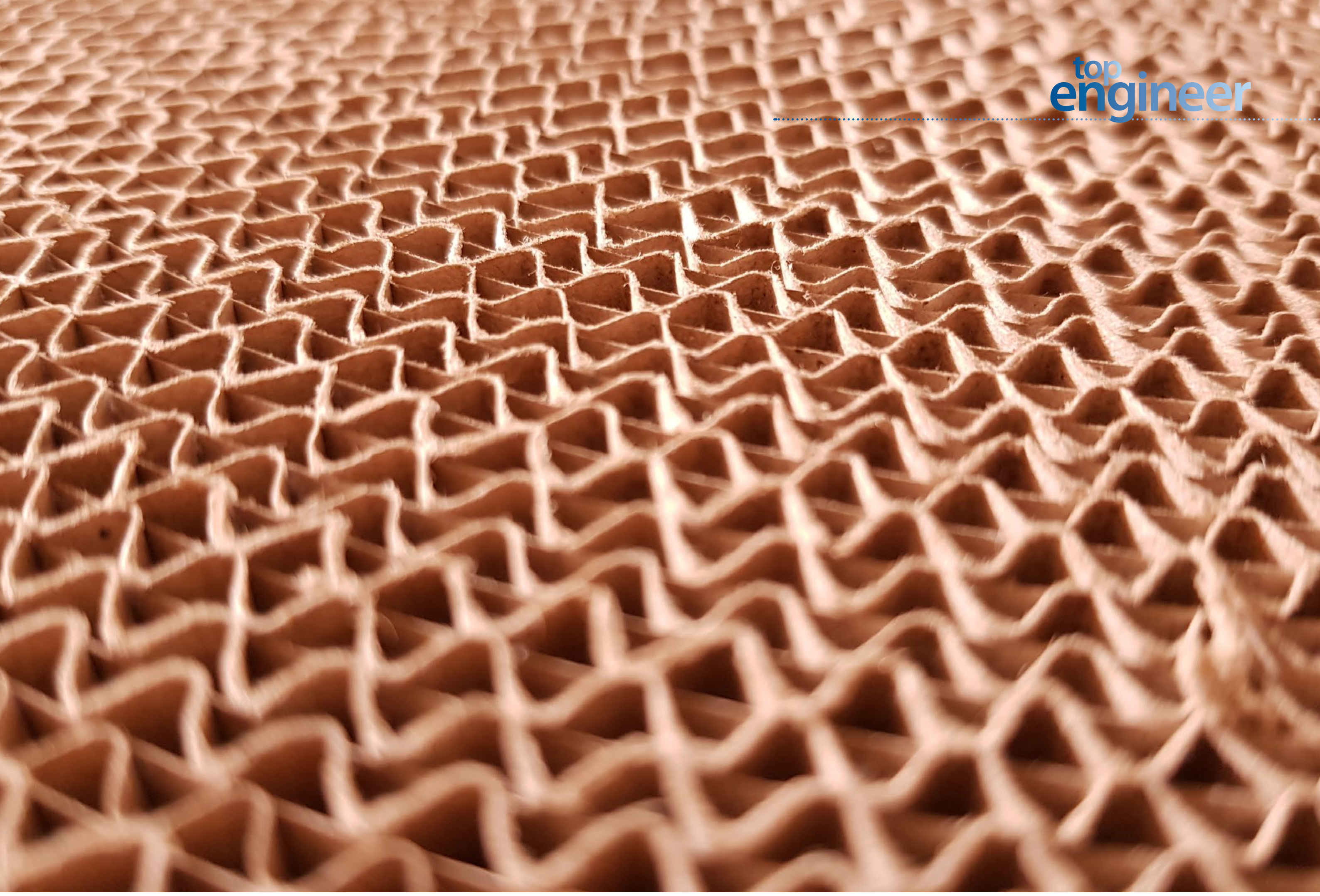
In the wider concept of bio and circular economy, the production utilises naturally occurring renewable materials, waste or sidestreams of another operator and develops new products with innovations and technologies. In these cases, the challenge is to optimise the feed and to get constant capacity.

Also scaled, reasonably priced and agile technological solutions may turn out to be difficult to find for the production stream and quality fluctuations. New occupational and chemical safety issues may also arise with circular economy cases.

From challenges to solutions

A wide network of technology providers must be utilised with whom we can create tailor-made equipment and systems, if necessary.

Technical consulting and engineering offices have expertise in a process



"A new scale-up process can be realised only with innovative, economic-technical solutions."

and plant design as well as clean utility systems with applicable occupational safety features. A partner who is responsible for the product recovery and supporting utility and energy systems is useful, while a plant owner usually focuses on the fermentation (cultivation of microorganisms) itself.

Experts and consultants for circular economy projects should be competent in feasibility studies, capacity calculations and dimensioning of equipment as well as risk evaluations. Clean room air condition and ventilation, clean utilities and instrumentation would also be great additions to this toolkit.

Finally, proper data acquisition and analysis are essential for calculating the effects of process variables on the final outcome in every development step. Process modelling is needed in order to optimise the process faster and more cost-effectively when targeting a well-functioning, industrial-level process.

Understanding fundamentals behind the process is a key factor to successful scale-up. And a link between customer R&D and equipment manufacturers is needed for hands-on knowledge. A new scale-up process can be realised only with innovative, economic-technical solutions.

About the author

Pasi Leimu
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Pasi Leimu has worked at Elomatic since 2001 and he is a very experienced project manager and process designer with good language skills. He has undertaken a wide range of different design, installation supervision and project start-up tasks. He has diverse experience in chemical-, metallurgical-, foodstuffs- and pharmaceutical industry projects with special expertise in consulting and ATEX directives.

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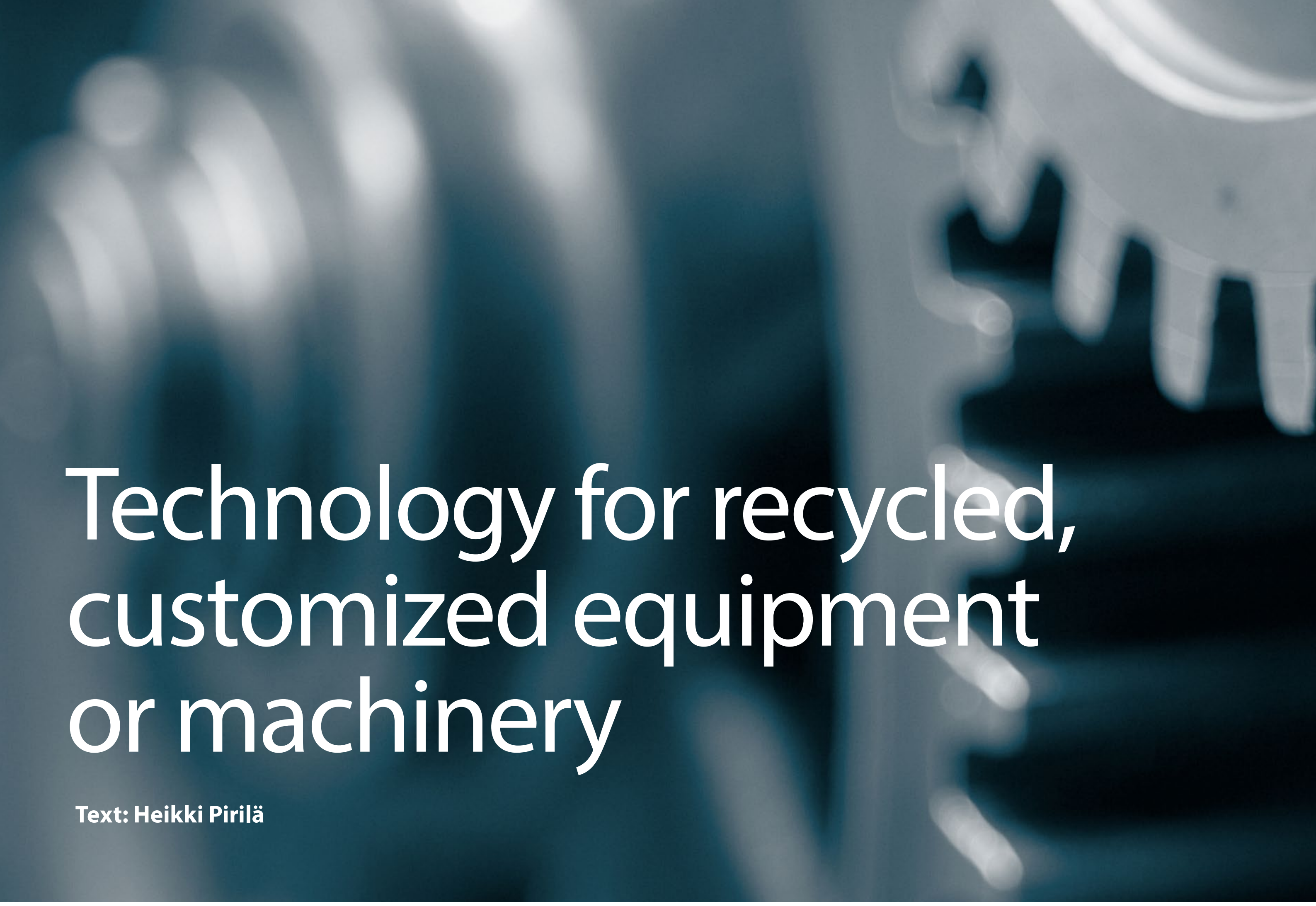

Technology for recycled, customized equipment or machinery

Text: Heikki Pirilä

It is easy to get your customer's attention when remarkable savings in purchase costs as well as in the schedule timetable can be promised. Compared to brand new machinery, the cost savings with recycled machines in an optimum case can be as high as 60 per cent. A similar reduction of lead time, or even more, can be achieved as well.

Naturally, there are several factors to be considered when calculating the final cost. The state of the machinery in question, the possible need for technological conversion and the cost of dismantling and transport to the reassembling place. Usually, start-up companies with their pilot projects get the biggest financial benefits of machinery recycling.

However, deep knowledge from a wide variety of industries is needed when looking for savings. We offer long-term experience in the acquisition of recyclable equipment as well as the possibility to perform their test runs and modifications - we have carried out several test runs of recyclable equipment together with customers and acquired and modified the equipment before re-commissioning.

Benefits of recycling

Using recyclable machinery can have some remarkable advantages compared to brand new machinery. Delivery time can be as much as a year shorter compared to new equipment. The larger the recycled entities are, the more considerable the benefits are.

Despite recycling and scaling, even entire plants can be converted. Reacting to changes in demand for example, e.g. paper mills can be converted to board mills.

In cases where recyclable equipment needs to be modified or upgraded for technical reasons, today's safety issues must also be taken into account and the equipment brought into compliance with the requirements. In some cases, good performance guarantees can be obtained from the equipment, but mechanical warranties less frequently. Good performance guarantees and mechanical warranties are always provided for new equipment.

Especially in limited-budget projects, e.g. in pilot plant projects, recycled equipment has been successfully used. We have broad experience of working with start-up companies in several areas, including bio-based materials. Together with the customer, we have provided all or several of conceptual design, basic design and/or detail design services together with implementation services for plants, scaling from laboratory to pilot, then from pilot to demo and finally scaling from demo to commercial.

These projects have taken place not only inside Finland, but also from Finland to other EU countries. One recent successful recycling project was

to move wheat starch machinery from Finland to Lithuania.

There is still no established technology for the processes of the currently strong growth of circular and bioeconomy. In this particular technology, there is a dual challenge. First, to find usable technology and second, to find appropriate machinery. We have been able to use our knowhow to help with these technology choices, for example in the food and pharma industry and process industry in general.

Finding suitable technology

The key is to find technology on a scale suitable for new processes. It is also possible to adapt existing technology to be suitable for another type of process.

We are able to combine GMP (Good Manufacturing Practice) knowhow from food and pharmaceutical processes to other process areas. With versatile and long experience in various process engineering assignments in the process industry, we are able to support startups that are already in the early stages of development. Evaluating the test arrangements and defining further tests together with the customers is an important part of this process.

Companies do not necessarily want their competitors to get information about changes in their production lines, investments or R&D plans. Therefore, a third party is needed to intermediate in selling unnecessary machinery or buying machines no longer needed in some other company. However, startups are the ones getting biggest benefits of recycled machines. Cutting costs and delivery times is a game changer for these companies. Accelerating pilot projects without costs is another driver.

About the author

Heikki Pirilä
Vice President

Heikki's special competences are project selling and execution duties in process industry. During his career he has participated in more than fifty various types of geenfield and rebuild industrial projects, both domestic and foreign, such as turn-key, EPCM and engineering projects including also project management and procurement tasks. Heikki is an excellent team player and his willingness to travel has gained him noticeable international work experience.

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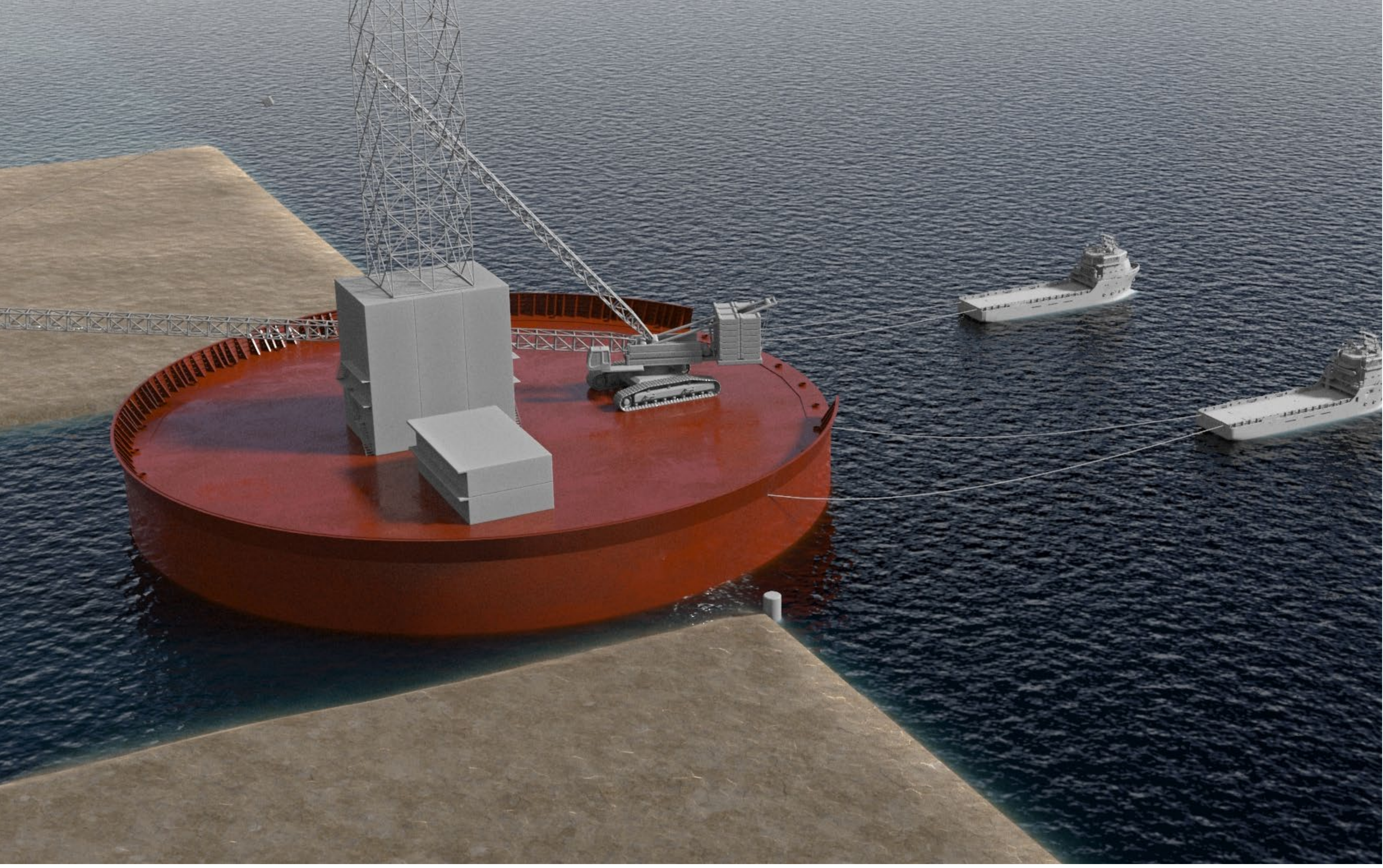

Stopping offshore lifting

Text: Ted Bergman, Heikki Välitalo

Offshore constructions are in new growth where the traditional oil&gas foundation applications are now expanded to the energy industry. The global warming is abated in many ways, the oil&gas industry is facing seawater level changes and improvements and more focus towards gas production. The worlds need for rapid increase of renewable energy turns especially wind farm applications to offshore growth. With growing offshore wind farms different types of energy handling stations as offshore platforms and islands are needed for use as substations, HVDC and hydrogen production.

The knowledge from years of experience in the traditional offshore sector have been packaged to a patent pending application enabling solid and cost efficient solution with minimal environmental impact and total removal after end of use.

The new concept is aimed for construction in shallow waters. In these cases traditional method have been to build rock island which have high costs and environmental impact. After the settlement time, installation of the topsides equipment starts. This can be replaced with a floatable steel island which after towage to offshore location is lowered and self-piled to seabed eliminating major parts of offshore construction. From construction

"The worlds need for rapid increase of renewable energy turns especially wind farm applications to offshore growth."

	MONO	MULTI	ISLAND
Wind power substations	YES	YES	YES
Logistic hubs	YES	YES	YES
Accomodations / Living quarters	YES	YES	YES
Wind turbines			YES / submerged
Hydrogen production			YES
Drilling and production facilities			YES
Heliports			YES
Satellite wellheads			YES
Normally unmanned artificial islands			YES
Piers	YES		
Bridges	YES		
Bollards, jettys and anchorage fixed points	YES		
Helipad	YES		
Refloatable power station			YES
Ice protection barriers	YES		
Flood protection barrier		YES	

"From environmental perspective at end of use the artificial island is simply refloated and brought to a location where the steel can be scrapped for reuse."

point of view offshore lifting operations can be minimized lowering costs and risks. The steel island withstands harsh conditions, such as ice, and do not need protection barrier repairs after each winter.

The floatable feature is designed so that on-shore construction can be done in various conditions. Even a sand shore can be used or then construct it in a ship yard dependent of customer demands. After construction the steel island with already onshore installed topsides is floated and towed to site. This can be done even to very shallow waters.

Floatable Steel island provides a solution to shallow water field locations near shoreline where the traditional offshore lift vessels cannot operate.

From asset risk management point of view the island can be refloated and relocated. From environmental perspective at end of use the artificial island is simply refloated and brought to a location where the steel can be scrapped for reuse.

For whom is this to consider? Just about any topside construction can be applied. If you have a project independent it's a foundation for wind mill, wind farm substation, hydrogen production, oil&gas field development for drilling rig, processing island or accommodation quarters. You may be looking into service hubs or just as a monopile for ice protection to your harbor or perhaps you need a platform for vessel surveys with independent drones. In any case you will get environmental and financial benefits with a solution that do not need typical offshore construction such a lifting, dredging, hammering. The application is suitable from dense to soft sea bottoms where you might have difficulties of finding other suitable methods.

The floatable steel island's key benefits are:

- Low total project cost
- Shallow water construction possibility, logistics
- Short total project schedule
- Easy and safe to construct, transport and install
- Environmental friendliness
- Ice resistance without ice barriers
- Maximizes Local Content possibilities

About the authors

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Project Director for Offshore

Heikki Välitalo joined Elomatic in 2019 as Project Director for Offshore Projects. His professional experience dates back to 1980's and covers design, sales, project management in offshore oil & gas field development projects, as well in platforms / drilling rigs related projects.

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Ted Bergman joined Elomatic in 2019 as Vice-President with a focus on developing international business. His professional experience dates back to 1995 and covers sales, design and commissioning tasks in e.g. the power industry, pulp & paper industry, and process industry.

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ELOMATIC

CONSULTING & ENGINEERING

We at Elomatic have donated to UNICEF Finland, as we want to make our share in relieving the global pandemic, especially the difficult situation India is facing.

There's a rapid growth in COVID-19 cases in South Asia, which already accounts for half of the new COVID-19 cases globally: over three new cases in every second, and a new COVID-19 related death in every 17 seconds.

Over a quarter of the children of the world, almost 627 million, live in South Asia. Especially the most vulnerable – including children – are in need of working healthcare – which now is in danger of collapsing, since COVID-19 patients fill up the hospitals.