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**HENRIK HOLOLEI**

When Rail Baltica will be completed it will show where we chose to be



**ANDRZEJ FAŁKOWSKI**

Security implications of the Baltic Pipe Construction Project

**ALEKSI RANDELL**

The Russian invasion war will not collapse the Finnish economy, but it revealed weaknesses



**KIMMO LUNDÉN**

Finnish construction export changes its form



# BALTIC RIM ECONOMIES

The Pan-European Institute publishes the Baltic Rim Economies (BRE) review which deals with the development of the Baltic Sea region. In the BRE review, public and corporate decision makers, representatives of Academia, as well as several other experts contribute to the discussion.

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JAAKKO LEHTOVIRTA

# Finland and Ukraine's reconstruction

Expert article • 3307

Russia invaded Ukraine in 2014. Annexation of Crimea was a brutal blow to the rules-based international order. The following 8 years were marked by continuous violation of Ukraine's sovereignty and neglect of international law. Global outrage and sanctions did not stop Russia. February 24th of this year brought a full-scale invasion. However, Ukraine managed to stop the onslaught, and Russian army failed to capture Kyiv. With the help of the international community, Ukraine has turned the tide and liberated significant areas of its territory.

Unable to match the skill and motivation of the Ukrainian armed forces, Russia has since 10th of October resorted to massive terror bombing of Ukraine's energy system. Strikes against civilian infrastructure reached another peak on 23rd of November. Ukraine is now in dire need of technical and financial assistance to get through the winter. However, Ukrainians are not giving up. In the middle of the war, they are planning for further liberation and reconstruction of their country.

When does reconstruction start? The question is somewhat academic. Ukraine cannot wait until hostilities cease for good. I see reconstruction as something that has already begun, but is bound to increase exponentially as remaining occupied areas are liberated and the military threat decreases. Fixing the damaged electricity infrastructure is an ongoing part of Ukraine's reconstruction.

Full reconstruction of the war-damaged country is a massive task, comparable to the job Europe faced after World War II. In September, World Bank, European Commission and Ukrainian government estimated the cost of rebuilding Ukraine to be around 349 billion USD. That was before the campaign against Ukraine's energy infrastructure. Now, the cost keeps rising by the day. All fighting causes inevitable damage. There is also the haunting unknown of what has happened in the Russian-occupied territories, some held for over eight years.

Who will coordinate the reconstruction effort? In Ukraine, it is up to Ukrainian government to decide. Requests for help come from all levels, and if it is easiest for cities to work directly with foreign cities, let it be so. Still, it is perhaps useful to avoid parallel efforts at every level. There are also initiatives for countries to take patronage over a certain region. Occasionally it may work, but some feel a sectoral approach might be better.

Internationally, there may be a need to identify a guiding organisation or establish a system to direct funding for reconstruction. Ukraine is a European country with an EU membership perspective, and a strong EU role would feel natural. The German Marshall fund has concluded that the effort needs a G7 figurehead, preferably American, to ensure a lasting non-European commitment. Whatever way we go, the key is not to turn this into a donor turf war but keep focus in Ukrainian needs and donor efficiency.

Ukraine's task is to maintain donor confidence. That requires uncompromising transparency, independent overview and steady progress with reforms. The seven points expected by the European Union are a good start. The willingness to help and the willingness to invest go hand in hand: one wants to know where the money goes.

Finland welcomes the EU candidate status of Ukraine, and we will support the reforms required. Principles guiding the enlargement policy remain, including the merit-based approach. This is not inflexibility.

Ukraine would not benefit of membership in a union that compromises its own recipe of success. Ukrainians are not sacrificing this much simply to return to where they were before 2014. They deserve better. Europe, in turn, needs a flourishing Ukrainian economy.

Finland is ready to take part in Ukraine's reconstruction. As a start, we can provide expertise in education, rule of law, energy security and climate resilience – cornerstones of our long-term development cooperation with Ukraine.

Finnish businesses have a lot to match Ukraine's reconstruction needs. Our companies provide solutions to energy needs: power plants, smart grid solutions and nuclear energy knowhow. Telecommunications and digitalization are well covered. Water and sanitation solutions help rebuilding damaged cities. We are good in planning, engineering and management, when it comes to one of the biggest infrastructure need: roads and bridges. There are great solutions for housing and waste management.

There will be increasing competition, which is welcome. Russian market has turned toxic. Several companies, big and small, are looking for new partners and regions for investment. Ukraine with its large population, rapidly developing business environment, European perspective, fertile soil and – most importantly – impressive pool of human capacity will be an attractive destination. I remain confident that Finnish business is finding its role in Ukraine's reconstruction. ■



JAAKKO LEHTOVIRTA

Ambassador of Finland to Ukraine

PETRI VUORIO

# The Ukraine reconstruction - towards the European and Finnish solutions

Expert article • 3308

Russia's unjustified war of aggression in Ukraine has caused widespread destruction and humanitarian suffering. Finland and the Finnish businesses condemn Russia's aggression and strongly support Ukraine and its citizens.

Finnish business sector stands behind the EU sanctions against Russia, as it has done since 2014. Finnish companies are among the most active ones leaving the Russian market. Our trade with Russia has dropped dramatically as companies do not want to do business with Russia.

Russia's current unhuman airstrikes to Ukrainian energy infrastructure cause human misery for millions of people. There is a drastic need for emergency aid in Ukraine to survive over winter. Finnish companies do their utmost to find for example aggregates to be delivered as emergency help to the Ukraine and Ukrainian people.

Even though the war continues, it is already worth starting to plan the longer-term reconstruction of Ukraine, which is being prepared between the Ukrainian government and its international partners.

According to an estimate published in September 2022 by the World Bank, the European Commission and the Ukrainian government, the need for reconstruction in Ukraine stands at approximately USD 349 billion. As the war continues, the need for reconstruction becomes increasingly pressing.

There is an enormous need to reconstruct the destroyed

1. energy infrastructure, like the power transmission and district heating networks
2. transport infrastructure as for example approx. 17,000 km of road networks and 3.4 million m<sup>2</sup> of bridges need to be repaired
3. telecommunications and digital infrastructure
4. waste and water management
5. housing and school reconstruction as at least more than 800,000 residential units are damaged and almost 200 schools have been completely destroyed and 1,700 schools partially.

In addition to these infrastructure investments, there is a tremendous demand of physical and mental health services and educational services to bridge the learning gaps the unjustified attack by Russia has caused.

The European Union is playing a key role in the reconstruction, coordination and financing. It is preparing a reconstruction platform, where financiers and the Ukrainian government would coordinate projects for reconstruction, as well as their prioritization, implementation and monitoring.

The reconstruction of Ukraine goes hand in hand with Ukraine's closer relations with the EU. Ukraine was granted the status of the EU candidate country in June 2022. Finnish industries support this development.

Finland is preparing to contribute to the reconstruction and offers

the expertise of the Finnish companies to support needs of the Ukraine. The scale and complexity of the reconstruction requires close cooperation and the efficient exchange of information between public authorities, businesses and financiers. The Confederation of Finnish Industries EK plays a vital role in coordination at this preparatory stage.

As Ukraine does not only want to reconstruct old, but also to modernize its society, Finnish companies have a lot to offer as they are at the leading edge in green and digital transition and sustainability.

In energy sector we have a strong knowledge for example in power grids and district heating solutions, and in nuclear power consulting. In telecommunications and digital solutions, Finnish companies can provide world-leading solutions to support the reconstruction.

Finnish companies also have a lot to offer when we speak about low-emission machinery and equipment to meet climate targets. We have strong planning, engineering and project management know-how for bridges and roads and water supply and sanitation issues. We are also leading constructors of wooden buildings, school modules and prefabricated solutions.

For agriculture and forest sectors we build tractors, threshing machines and forest machines.

Finally, Finnish companies are important players in healthcare and education. We have solutions for specialised healthcare hospitals and technology solutions for the elderly and rehabilitation. In field of education, we can offer services in teacher training and digital services to fill the competence and talent gap.

Funding of reconstruction will consist of grants and loans. The Commission has proposed a 'Rebuild Ukraine' financial instrument, in which non-EU partner countries could also participate. The key objective should be to tie any funding to reforms in Ukrainian society, including anti-corruption measures, good governance, transparent procurement processes and effective control mechanisms.

It is important that tendering in reconstruction projects, using either international or domestic direct financing, is organized in a sustainable and transparent manner. The international development finance institutions which are used to operate in emerging markets and developing countries, play a key role in ensuring supervision and transparency. In the EU and Finland, it is essential to assess the need of new financial instruments that match Ukraine's reconstruction needs by integrating elements of the export and development financing.

We stand with Ukraine. To make our strong support visible there have been four Ukrainian flags waving on flagpoles at the headquarter of the Finnish Industries, every day since February. ■

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TOMMI TUOMI

# Vertical wood: Sustainable re-building in Ukraine

Expert article • 3309

The reconstruction of Ukraine is a common European challenge. The task is enormous and will require cooperation across the borders, between local communities, companies and political decision-makers. One of the priorities is to rebuild the houses, roads, and other critical infrastructure destroyed by Russia. Even if the war is still ongoing, and the scale of the required financing for reconstruction is unknown, it is time to think about the future and joint efforts of rebuilding homes for Ukrainians.

To seize the opportunity, now is the time to think how Finnish companies and the Ukrainians forced to flee the war, and those still living there, could participate in the re-building of the country. At best, we could build a model that would support people's employment in Finland and in Ukraine, and at the same time, give the opportunity to do something concrete for the country. A good example could be construction companies e.g. Vertical Wood construction. The home made by Vertical Wood company would be assembled in Finland by local Finnish and Ukrainian workers and erected in Ukraine with the help of local labor. This kind of model would have numerous favorable effects in both human and financial terms.

Although there is an urgent need for protection and humane conditions for those who have lost everything, it is also vital to pay attention to environmentally friendly and long-lasting solutions that emphasize the use of renewable materials, sustainability, cost-effectiveness and quality of living. All of these criteria are met when wood is used in construction. Wood has been proven to be an excellent building material and make buildings last for decades. Finland is a pioneer in the wood construction industry with high quality, innovative and up-to-date solutions.

The Vertical Wood construction is an excellent option for rebuilding of Ukraine's civilian infrastructure. It is a fact that building from vertical wood is fast and easy, but it is also cost-effective, environmentally friendly and scalable. This means that the building will not be a temporary solution even though initially built as emergency accommodation. Potential for easy future expansion makes the vertical wood building completely unique. It can be easily expanded if the emergency shelter built is to be expanded to a family home in a few years.

The reconstruction of Ukraine must be seen as a task for the whole world. It is a huge challenge for political parties, countries, alliances, companies, people, humanity and financial enablers. But it is still a joint effort where everyone is needed and also the micro businesses shall have an important role. Environmentally friendly, cost-effective and scalable Vertical Wood construction method takes our know-how forward to the world and also contributes to the growth of Finnish and Ukrainian economy. All in all, we have a unique opportunity to build new networks that are critical for sharing best practices and knowledge required for rebuilding of Ukraine and helping those in the greatest need. ■



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# How can the Turku region of Finland contribute to rebuilding Ukraine?

Expert article • 3310

In the early hours of October 8th, a few trucks were crossing from Russia into the occupied Crimea via the Crimean Bridge – Vladimir Putin's pride and glory. When the air was starting to fill with the smell of an early dawn, a powerful explosion shook the bridge and several spans fell into the sea. This explosion triggered a whirlwind of hatred in Kremlin, which subsequently erupted in a barrage of missiles and drones aimed at Ukraine's critical civilian infrastructure accompanied by loud applause and cheering from the Russian propaganda.

It has been mind-blowing to observe the propaganda narrative shifting from helping oppressed civilians in the so called "Luhansk and Donetsk Peoples' Republics" in Eastern Ukraine in February to systematic daily acts of terror and destruction of infrastructure across the entire country since the bridge was damaged. It seems that the Russian government no longer views it necessary to hide behind a mask of virtue.

During the first days of this war, we here in Finland couldn't help but recollect the 1930ies Soviet fake news about the Soviet Air Forces merely "dropping bread to the starving masses of Helsinki" whilst in reality they were caring out brutal air raids. In 2022, we watched how the history made a circle as Russian propaganda talked about helping 'oppressed civilians', this time in Ukraine.

Even though most Russian missiles and drones are taken out by Ukrainian air defence forces, many do reach their targets and destroy infrastructure across the country. By the end of October energy infrastructure in almost all regions has been damaged. This, according to Vladimir Zelenskiy, constitutes c. 40% of all UA energy infrastructure. Amongst the key damaged sites there are hydro power stations in Zaporizhja, Nova Kakhovka and on the Dnister river, Zaporizhska nuclear power plant which has been under Russian occupation since March, several crucial water pipelines of the Dniprovodokanal, infrastructure in Kyiv that left 350 thousand flats without electricity and c. 40% of the capital population without water, numerous powerplants. According to the estimate of Kyiv School of Economics, as of 8 June 2022 total direct damage to infrastructure is estimated at USD103.9bn. One can only imagine what an updated number looks like if we take into account recent targeted infrastructure bombings.

No region is safe, there is no guarantee that tomorrow there will be any running water, electricity, or stable internet connection. Lives of many people have already been severely disrupted, and many more are living in uncertainty and constant danger. However, despite all the horrors of war, the Ukrainians have already started to rebuild the country. As quick makeshift repairs are being carried out daily, we can already hear initial talks about how the infrastructure can be reconstructed and how fast this can be done after the war ends. However, it should be noted that most of Ukraine's infrastructure was built in the USSR times using technology that was available back then. The post-war reconstruction will most certainly be carried out

by Western companies and needs to be performed applying modern, cutting-edge technologies and best practices from Europe and other developed countries.

As winter sets in, the Russian army focuses its attacks on two key parts of the infrastructure – energy and water. It goes without saying that living without electricity is very difficult but surviving without water is nearly impossible. Let's look at Kherson, a city recently liberated by the Ukrainian army which was home to around 300 thousand people before the war. Nowadays, less than a third of Kherson's original population remains in the city. Residents report that there is no gas, electricity, and water. The occupants destroyed large parts of the infrastructure when they were retreating. People draw water directly from the river Dnipro to use it for cooking, washing, etc.

Another example of significant damage to the water infrastructure is the destruction of the Dnipro-Mykolaiv water supply system which used to provide water to more than 1 million people in the Mykolaiv region. It was damaged in April and continuously shelled during the stand-off between the Ukrainian and the Russian armies. Specialists examined 36 km of water pipes and found major damage in four places as well as at the pumping station. When the Russian army carried out these inhumane acts back in April, there was hardly any water supply in the city for over a month. Intermittent supply of service water was later established from another river – the Southern Bug – and drinking water is being delivered via storage tanks. When activists checked the quality of the tap water, it turned out that the concentration of hazardous substances exceeded the norms by at least 8-10 times.

It is difficult to predict when and how this war will end but we can already start thinking about how to rebuild infrastructure using European technologies and best practices. For example, Turku Region Water Treatment Ltd is well equipped to provide insights regarding how to organise a high-quality water treatment in Ukraine (both domestic and wastewater) in an ecological and energy efficient way. Let's have a look into how this process is currently organised in Turku in a bit more detail.

Turku economic region has c. 300,000 inhabitants. Its industrial consumption is estimated at c. 65,000 m<sup>3</sup> of water daily. River water is purified via a natural filtration process via pumping it through sand and gravel ground to get artificially produced high-quality ground water. Turku has already achieved outstanding results in terms of water quality, e.g. in removing phosphorus. Energy efficiency is also impressive since the process generates more than 10 times as much energy as it consumes. Sludge from the process is used to produce biogas that is subsequently used for heating, generating electricity and transport fuel.

Turku region's approach to water treatment has been recognised as one of the best in the world. This is exactly the kind of solution Ukraine will need after the war not just to rebuild infrastructure but to lay a solid foundation for a democratic society. After all, water is the basis of life and, naturally, a high-quality water system that is also

Expert article • 3310

energy efficient is an attribute of a healthy society.

The Turku region of Finland, its businesses and industry have a lot to offer in terms of rebuilding Ukraine after the war. Several major initial steps in this direction have already been taken. Since February, Turku has been supporting Ukrainian refugees arriving in the city as well as cooperating closely with the Embassy of Ukraine in Helsinki. As a result of this cooperation, the Mayor of Turku Minna Arve and the Mayor of Kharkiv Ihor Terekhov signed a twin city agreement in August. The agreement outlines general directions of cooperation, areas of support and knowledge sharing. As you are reading this article, business leaders and the city representatives of Turku are formulating initiatives, carrying out scope analysis and resource planning.

This war will end. And when it is over, a long and resource-heavy reconstruction process will begin. The Turku region of Finland has already started conversations with its Ukrainian counterparties and will further deepen this work in order to be well prepared when the timing is right. ■

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AAPO CEDERBERG

# The cyber war in Ukraine

Expert article • 3311

Ukraine is currently waging the world's first cyber war. However, cyberwarfare is not an isolated entity; its events and goals follow the course of physical war. At the moment, it seems that Ukraine has achieved a defensive victory in cyberspace, but it is difficult to draw final conclusions while the war is still ongoing. Assessing the efficacy of cyberwarfare is challenging because parties only share information beneficial to their own interests. Information related to cyber defense is sensitive and thwarted attacks are generally not reported openly to obscure defensive capabilities. The same applies to offensive operations, for example, attempts are made to conceal successful intrusion into the enemy's information networks.

## Successful cyber defense of Ukraine

When the Russian war of aggression began, many experts expected Russia's supposedly superior cyber performance to lead to significant results and extensive disruptions to Ukrainian networks. However, as the weeks turned into months, there has been no signs of major successful cyberattacks. The success of cyber defense can be observed, but it is more difficult to understand the underlying reasons. The reality of how many and how large-scale attacks Ukraine has managed to repel will become clear only after the end of the war, or not at all. One can, with caution, judge the factors that have significantly contributed to the success achieved so far.

One of the most important factors to the success has been the importance of international allies. Even before the war, Ukraine received substantial support for its cyber defense from western countries. This assistance increased even more after the invasion began. In addition to the assistance provided by major states such as the USA and the UK, many international companies have contributed to the success of the defense with their support. The threat information shared by Microsoft and the satellite connections maintained by Starlink are good examples. Moreover, for several years before the February invasion, Ukraine had been the target of a significant amount of Russian cyberattacks, thus, know-how and experience in countering attacks are at a high level.

Another factor that played a pivotal role was Ukraine's ability to physically move its critical servers beyond Russia's influence and make effective use of various cloud services to back up data. Initial missile strikes on data centres in the early part of the war were partly ineffective, as the most critical servers had been moved to neighbouring countries or outside the missile range. In addition, many nationally important online services operate entirely in a cloud environment.

Throughout the war, various experts have speculated that Russia has not yet used its most powerful cyber weapons but has saved them for a situation where the impact would be maximized. The most powerful cyberweapons are often disposable or single-use in nature, so their utilisation is naturally carefully considered. Throughout the summer and autumn, it has been speculated that either sooner or later Russia will have to employ all its remaining resources. When no significant increase in the level of cyberattacks is observed, it can be concluded that the most powerful weapons either have in fact been used earlier in war or never existed at all. However, none other than

Russia knows how much capacity it has in its reserve.

It should be noted that there is a stark difference between winning singular battles and winning the war. Cyber defense differs from offensive operations in that it must be continuous in nature. The aggressor can often decide the time and place of the battles. Even if there is a ceasefire in traditional warfare, cyberattacks can sustain the conflict. The defender must constantly prepare for new types of attacks, while the attacker can plan and prepare his actions in relative peace. Ukraine must therefore maintain and develop its own capabilities even further. It is also critical that Ukraine can justify to its allies its need for continued support in cyberspace despite Ukraine's seeming upper hand.

## Ukraine's counterattack in cyberspace

Counterattacks are an essential part of defense in cyberwarfare. Most of Ukraine's cyber capabilities are supposedly tied to defense and maintaining its own operational capability. There has been hardly any signs of offensive cyber operations carried out by the Ukrainian armed forces in open sources, but this does not mean that they do not happen. Despite a majority of resources being tied up in defense, it is possible that the Ukrainian armed forces will also carry out their own cyberattacks against Russian military targets. It is likely that these operations will not publicly discussed.

Cyberattacks for the benefit of Ukraine have been carried out not only by the armed forces but also by a wide range of volunteers from all over the world. As it is relatively challenging for outsiders to participate in the defense, volunteer activities generated by international media attention were used for cyberattacks against Russia. The cyber war has involved not only existing hacker collectives (the most famous of these being Anonymous) but also individual volunteer citizens from different Western countries. To coordinate the activities of volunteers of varying skill levels, Ukraine set up the Ukrainian IT Army, which coordinates attacks and distributes tools and instructions for their implementation. Indeed, the IT army and external hacker collectives have been responsible for numerous, now thousands, cyberattacks against Russia.

In the early stages, the attacks were largely denial-of-service attacks on Russian services (banks, online stores) or momentary takeovers or harassment of means of communication (TV channels). The purpose of these was to make the war palpable and visible to Russian citizens. As the war has continued, operations have been developed and expanded. The effectiveness of denial-of-service attacks has been improved by precisely timing them to the moments when the targeted service would have been most needed. Examples of these inventive denial-of-service attacks include widespread outages in Russian tax services moments before tax returns are filed, or the inoperability of online services selling equipment in October, as thousands of forced recruits seek to acquire equipment when they go to war.

The IT army of Ukraine is developing its activities; creating more effective and new types of attacks. This became concrete when, at the beginning of November, it announced that it had carried out several successful data breaches of Russian civilian and military targets. Data breaches differ from denial-of-service attacks, in that they require

more advanced expertise and knowledge of target systems. The constantly evolving operations reflect both the growing competence of the implementers and the ongoing motivation to continue efforts as the war continues.

### Russia's accelerating but blunt cyberweapon

The expected sophistication of Russian cyber operations presented by Western threat assessments before the war was higher than what its operations in Ukraine have indicated. This does not mean that all Russian cyberattacks were bad or unsuccessful. According to Microsoft, some of the cyber weapons used have been highly advanced and have produced results. Notwithstanding, the successes of the Ukrainian defense and the rapid recovery from the blows have kept the effects moderate.

In February 2022, and prior, Russia sought to cripple Ukraine's readiness with malware that destroys data and information systems. As in the Russian ground offensive, momentary and regional impacts were achieved, but the goal of an attack crippling society was not met. During the summer, as the front lines stabilized, cyber intelligence took a larger role alongside destructive attacks. In the autumn, Russia supported its missile attacks on Ukraine's critical and energy infrastructure with cyberattacks - although the effects have not been significant. Victor Zhora, head of Ukraine's cyber defense agency, said that during the offensive phase, the attacks were more sophisticated and continuous, but currently have become aimless and opportunistic.

Long-term cyberwarfare can be thought of as favouring the defender. When it comes to the most efficient weapons, the aggressor's reserves are quickly depleted, and the development of new ones does not happen overnight but requires intelligence and creativity. On the other hand, a well-functioning and up-to-date cyber defense system are more time resistant. Already at the end of the summer it was estimated that Russia's cyberweapons are starting to become dull and are only slightly modified versions of previously used malware. Russia has already used the footholds in Ukrainian networks it had previously obtained at the beginning of the war and has not been able to penetrate back as effectively.

From the outside, the effectiveness of cyber weapons can only be assessed in the cases that have been reported or have caused visible effects. When considering Russian cyberattacks, source criticism in both directions should be considered. Its own normally exaggerated propaganda has been surprisingly moderate regarding cyberattacks. It is also not in the interests of Ukraine or Microsoft - a strong supporter - to detail the losses or attacks that have bypassed the national cyber defense.

While Russian hacker groups have carried out visible cyber sabotage or attacks in Ukraine, Russia has used fewer external actors than estimated in its cyber operations. According to the information security company Trustwave, the cyber operations have mainly been carried out by Russian intelligence services or by various security authorities, mainly under the auspices of the GRU.

Mandiant estimated in November that the war has significantly changed the GRU's cyber operations. The cycle between intrusion into systems and the actual destructive effect has accelerated because of the desire to get effects faster in cyber warfare. Straightforwardness

is reflected in the simplification of malware, which in addition is not sought to be hidden and disseminated, but only to achieve the desired effect on a particular system. In the long run, increasing the speed will dull the impact of cyber operations and affect Russia's ability to develop new cyber weapons.

### The escalation of cyberwarfare

The cyber war between Ukraine and Russia has had a lot of ramifications. However, it has so far been more local and limited than anticipated. Before the beginning of October, destructive cyberattacks outside Ukraine's borders had not been seen, or at least could not be clearly attributed to Russia.

In its report, Microsoft estimated that the Prestige ransomware campaign targeting Polish logistics operators from March to October was the first destructive cyberattack of the Ukrainian cyberwar outside the country's borders. According to Microsoft, the attack was carried out by IRIDIUM, a Russian actor linked to the Sandworm group under the GRU. What makes a destructive attack is the impact on the target's systems, the loss of data leading to disruptions or the inhibition of operation. In cyberspace, the spill over effects of the war in Ukraine has been seen in the past in the form of denial-of-service attacks carried out by Russian hacker groups such as Killnet in countries such as Norway, Lithuania, and the United States. However, their impact has been more in the information dimension, i.e., visibility and fearmongering.

Russia has tried to influence aid to Ukraine unsuccessfully, both by means of using energy distribution as a weapon and by economic intimidation and pressure. Interfering with humanitarian and armed assistance outside Ukraine may be the next step, and in this direction, the utilisation of the cyber dimension is probably more likely than kinetic influence. Logistics critical to assisting Ukraine in Poland and Eastern Europe is therefore a potential stage to which cyberwarfare can spread.

The identification of cyberwarfare operations is challenged by their separation from cybercrime. Since the actors and forms of attack are the same in Russia, the real purpose can be hidden behind the shadow of crime. Thus, the fog of war challenges the creation of a cyber situational picture. The fog conceals both criminal and state threat actors who can operate whilst attention is elsewhere. This is true not only in Ukraine and Russia but also on a global level: the threat of cyber espionage and operations by traditional threat actors such as China, Iran, North Korea, or terrorist organisations must be prepared for as before. However, the final analyses and lessons learned assessments will not be available until after the end of the war when actors can more openly report their findings. ■

Expert article • 3311

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# BALTIC RIM ECONOMIES

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# The Baltic Sea: A shared responsibility

Expert article • 3312

**T**he Baltic Sea is an inland sea shared by various EU and Nordic countries. As the EU climate bank, the European Investment Bank is therefore fully committed to supporting environmental and blue economy initiatives in the region to meet the challenges of the green transition and climate change.

Climate change and the green transition are high on the political agenda of all democratic nations around the Baltic Sea. We have eight years left to meet the United Nations Sustainable Development Goals. Meanwhile, to meet the goals of the Paris Agreement, we must get to net zero by 2050, with a 50% reduction in emissions by 2030. The urgency of meeting these targets cannot be overemphasised. How can we balance this with the need to maintain a long-term strategic focus on meeting the Sustainable Development Goals? Financial markets and institutions can and should play an important role in driving investment for a healthy Baltic Sea and a sustainable blue economy. As the EU climate bank, the EIB is addressing the threats to marine and coastal ecosystems through its ambitious target to devote 50% of its financing to climate action and environmental sustainability.

Specifically, the EIB is contributing to the Baltic Sea's well-being through the EU Strategy for the Baltic Sea Region (EUSBSR) and the related blue economy agenda through lending, advisory services and key partnerships that support the European Green Deal in many different projects. Below are a few examples of projects that the EIB has supported for a better, shared future in the region.

In the field of wastewater management, the EIB has supported major projects in Sweden, Latvia and Lithuania, to name but a few. In 2021, the EIB granted a €97 million loan to upgrade the Käppala wastewater treatment plant in the Stockholm archipelago. The upgrade will enable the facility to deal with wastewater from up to 900 000 people in the Stockholm region, which is expected to have a clear, positive impact on the environment and water quality in the Baltic Sea.

In 2021, the EIB provided a loan facility of up to €50 million to Vilniaus Vandenys to improve two wastewater treatment plants and rehabilitate the water collection and distribution networks in the Vilnius metropolitan area. This has had a positive impact on residents in the area by reducing water pollution.

Likewise, this year the EIB financed the modernisation of the water management infrastructure in Latvia's capital Riga by providing a €60 million loan to SIA Rīgas ūdens. The investment loan will have significant environmental benefits through the reduction of groundwater and surface water pollution, and increased energy efficiency.

What do these water management projects in major Baltic Sea cities all have in common? A lot of investment goes into maintaining everyday drinking and wastewater infrastructure. The projects' local positive effects are expected to have a positive knock-on impact on

the environment in the entire Baltic Sea region. The key driver for these EIB investment projects is to ensure cost-efficient, continuous and safe water treatment and supply, as well as sewage collection and treatment, in accordance with the EIB's climate bank policy. The EIB has stepped up its support for major sustainable projects, where a huge need for investments in infrastructure exists.

At a global level, the EIB's support centres around its EIB Clean and Sustainable Oceans Programme, including the Blue Sustainable Ocean Strategy, which supports sustainable ocean-based projects in four sectors: green maritime transport, sustainable seafood production, sustainable coastal protection, and ecosystem preservation. Over the last five years, the EIB has provided over €50 million in funding for sustainable seafood production in the European Union, including fisheries and aquaculture. In Finland, for example, we allocated €5 million in 2020 towards a €34 million sustainable aquaculture project that cleans and recirculates used water in a loop system.

Projects in the Baltic region supported by the EIB cover many sectors. These range from transport infrastructure and renewable energy to waste and drinking water management, as well as road projects. For example, in Estonia we have signed a €100 million loan with the city of Tallinn to support its sustainable urban renewal and development programme by upgrading public buildings, urban mobility, public spaces, green areas and municipal infrastructure. Another example is that in 2019, the EIB lent €70 million to support the construction of a new ferry between Vaasa in Finland and Umeå in Sweden.

## Energy challenges

The current geopolitical tensions arising from Russia's invasion of Ukraine have put the European Union's green transition plans in the spotlight. The climate crisis and the dependence on untrustworthy partners for our energy needs hasten the need for decarbonisation and highlight its strategic importance. The EIB has contributed to many important flagship ocean-based renewable energy projects. This is a key sector of the EIB's lending to the blue economy and contributes to reducing greenhouse gas emissions. Since 2003, the EIB has financed 31 offshore wind projects in Europe for a total amount of more than €10 billion. The EIB is also committed to financing the next major innovation in the sector — floating offshore wind energy. Our support for this technology includes a loan of up to €475 million for Danish Vestas Wind to support the development of low-carbon technology, products, and energy efficiency.

Intensified cooperation between national, regional, Nordic and EU institutions is vital.

The EIB acknowledges the need to scale up existing projects and green investments in the Baltic Sea region to facilitate the climate transition, for energy independence and strategic autonomy, and for the well-being of the Baltic Sea. Therefore, we look forward to increased cooperation with other international entities such as the

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Nordic Investment Bank, governments, banks and other private investors. The Baltic Sea is a matter of common interest for us all. ■

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HENRIK HOLOLEI

# When Rail Baltica will be completed it will show where we chose to be

Expert article • 3313

Since 24 February we live in a completely new reality following Russia's unprovoked and unjustified military aggression against Ukraine. The EU has shown immense solidarity with Ukraine from day one: politically, financially, militarily and with massive restrictive measures against Russia to reduce its capacity to wage this war. Within days of Russia launching its military aggression against Ukraine, we had imposed the largest sanctions packages of our Union's history. The extent and weight of these sanctions are unparalleled. These measures increase the cost for Russia to carry out its inhumane military intervention and place a considerable constraint on its military capabilities. Our aim is to cut off the Kremlin's capacity to wage war on its neighbours.

However, very quickly it became clear that connectivity would be key to support Ukraine's courageous and determined fight against the Russian aggressor. As a consequence of Russia's invasion and in particular the blockade of Ukraine's Black Sea ports, Ukraine as a major grain producer, was simply unable to export its agricultural goods in the necessary quantities. The disruption to transport links and export routes meant that grain produced in Ukraine could not reach traditional destination markets, and Ukraine's silos would not be empty in time for the next harvest unless alternative routes were found.

Transport stakeholders quickly reacted to Russia's blockade of Ukraine's Black Sea ports and, with the support of the Commission, frontline Member States, Ukrainian and Moldovan authorities, established new, alternative routes via road, rail and inland waterways between Ukraine, the EU and the rest of the world basically overnight – the so-called "Solidarity Lanes".

The Solidarity Lanes have become a precious and indispensable lifeline for Ukraine and also a safeguard against a global food crisis. Since May, they have enabled Ukraine to export more than 34 million tonnes of goods, including more than 17 million tonnes of Ukrainian grain, oilseeds and related products. They have generated over EUR 19 billion for Ukrainian farmers and businesses. And they have also allowed war-torn Ukraine to import more than 11 million tonnes of goods it needs, such as food, fuel and much-needed humanitarian aid. The Solidarity Lanes are here to stay. They will be turned into permanent transport and trade corridors between Ukraine and the EU, helping Ukraine move closer to our Single Market.

Rail has been essential to the export of Ukrainian grain, accounting for more than 1/3 of Ukrainian agricultural exports between May and July. However, the different rail gauges have undermined rail's potential. This has been particularly the case for the three Baltic countries. While they wanted to help Ukraine to maintain access to its export markets via their ports and also send back vital goods, the fact that trains need to change the gauge twice on the way from Ukraine to the Baltic ports makes this export route quite challenging and expensive. Nonetheless, Baltic countries have gone above and beyond to support Ukraine; the regular rail services between Ukraine

and the port of Klaipėda in Lithuanian are an excellent example of European solidarity.

Geopolitically, the Russian war of aggression against Ukraine underlines how important it is that troops and military equipment can travel through the EU swiftly to ensure the defence of the European Union and NATO territory. This point becomes even more relevant for the region as Finland and Sweden are joining NATO. Rail Baltica is being built to specifications that make it usable for both civilian and military purposes. Rail Baltica will also open up new routes to the Arctic, a region whose geopolitical importance is set to grow.

This just further highlights the importance of having a well-functioning and modern single transport area in the EU. Unfortunately that is still not the case, and connectivity is still an issue within the EU and we face many gaps and bottlenecks across the European transport network. The plane is the only realistic option for most people wanting to go to Finland or the Baltics from the rest of the European Union. If you do not mind driving hundreds of kilometres along country roads and if you are not in a rush, you might also consider the car. But this is clearly not a sustainable option. In other EU countries high speed rail brings cities closer together, allowing people to travel 310 kilometres from Brussels to Paris in one hour and twenty minutes or 620 kilometres from Barcelona to Madrid in two hours and thirty minutes. Rail can also carry large amounts of cargo to the ports.

In the Baltic States this type of connection is absent, leaving a major missing link in the trans-European transport network and the North Sea – Baltic corridor which should connect the north-western and the north-eastern regions of the European Union by 2030. Yet, better rail connectivity within the region and to the rest of the EU could also bring benefits for the Baltic States and for Finland, environmentally, economically and geopolitically. With this and the experience of the Russian war of aggression against Ukraine in mind, the Commission proposed new legislation in July 2022 to gradually unify the European railway gauge. As the first line in European gauge through the three countries, Rail Baltica will be one of the most important lines in this regard.

The environmental and economic benefits are clear: they include shifting transport from road to rail to meet the objectives of the European Green Deal and the Sustainable and Smart Mobility Strategy reducing CO2 emissions from the transport sector and the dependence on imported fossil fuels. During the construction, the work is being done in accordance with European environmental legislation, making it one of the most environmentally friendly railway line.

Good connectivity remains the basis for economic success and a precondition for a functioning, integrated internal market. It would enable the logistics sector in the Baltics and Finland to develop new markets. Rail Baltica also leads to huge European investments in the region. The European Commission has already allocated more than €1.2 billion to the project and much more is expected in the next



rounds of support under the Connecting Europe Facility.

Through this programme, the European Union can pay for 85% of the costs for multi-billion euro railway infrastructure because it is a cross-border project and a major missing link of the trans-European transport network. Getting this co-financing requires that the Baltic states will manage to meet the conditions that are attached to European funding, such as a timely delivery, quality thresholds, and construction and spending deadlines.

Although cross-border projects are never easy to implement, construction has started in all Baltic states. It is most obvious in the centre of Riga, where a new railway station is being built. Lithuanians too will have seen that access roads for the construction of the new railway line are being built and in Estonia people travelling from Tallinn in the direction of Pärnu see the new overpasses under construction along the way.

When it is completed Rail Baltica will also be a symbol. It shows how far the Baltic States have come over the last thirty years. In 2004, the Baltic States joined European Union and this enabled us to flourish and take a path of unprecedented social and economic development. When Rail Baltica will be completed, nearly 40 years after our regained independence, it will show where we chose to be when we left the Soviet Union behind to join the EU as free countries. We will have a real high speed and high capacity rail connection to the heart of the Union. ■



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# Security implications of the Baltic Pipe Construction Project

Expert article • 3314

**T**he Baltic Pipe is a strategic infrastructure project aimed at creating new gas supply opportunities on the European market. It will enable the transmission of gas directly from deposits located in Norway to Denmark and Poland, as well as to customers in the neighboring countries of Central and Eastern Europe. Baltic Pipe will also enable bi-directional gas transmission from Poland to Denmark.

Baltic Pipe is 900 km of the estimated total length of gas pipelines, including 4 gas compressor stations, which will give approx. 10 billion m<sup>3</sup> of gas pipeline capacity. According to estimates, this year's gas consumption in Poland is 18 billion cubic meters. The total volume of signed contracts is 2.4 billion m<sup>3</sup> gas per year for 10 years.

The investment runs from the North Sea, where it is connected to the Europipe II gas pipeline, thus ensuring access to gas from Norwegian fields. Then, by building infrastructure in Denmark and at the bottom of the Baltic Sea, the gas pipeline will connect to the Polish transmission system. The project is being implemented by the Polish GAZ-SYSTEM (a strategic company for the Polish economy, operating gas pipelines) and the Danish Energinet.

The task was carried out in two countries and on two seas in the exclusive economic zones of three countries. Thanks to the Baltic Pipe, it will be possible to become independent from Russian gas. When Russian aggression against Ukraine continues and gas cannot be bought in Russia (embargo), this is especially important. The Baltic Pipe and the LNG Terminal in Świnoujście make Poland an important natural gas distribution center in this part of Europe. As other countries will also be able to use natural gas, the European Commission has identified the Baltic Pipe as a project of common interest.

Gas from a different direction could be an alternative to Europe. For example, Turkey is considering three options for the supply of Turkmen gas (Turkmenistan has the fourth largest gas reserves in the world). Gas from this republic could become another alternative for Europe to unreliable Russia. Moscow does not like these plans because they would directly affect its interests.

Officially, Moscow does not comment on these plans. However, the act of sabotaging Nord Stream 2 in the Baltic Sea proves that Russia does not intend to passively follow the events. Detecting the cause of an attack is very difficult and almost impossible to prove to anyone, but it makes us think about securing this extremely important critical infrastructure. The damage to the Nord Stream 2 has made it clear that critical infrastructure, including underwater installations, is highly vulnerable not only in war, but even in peacetime.

It is crucial to prepare for their protection, even in international and domestic territorial waters. Their location must be kept secret. The mere fact of their location at the bottom of the sea and great depth is no longer enough. Controlling the activities of surface vessels may also prove ineffective in the context of current technological possibilities, such as sonars, underwater robots or unmanned underwater vehicles. Nowadays, there is no need to take advantage

of humans and put them in danger if the underwater tasks can be performed perfectly without their physical presence under water.

Interestingly, the same underwater pipeline protection systems as underwater robots, optoelectronic and acoustic systems, and underwater cables can be used simultaneously to detect and destroy underwater infrastructure. Thus, paradoxically, they have the feature that they can be used both to identify a threat and to cause it, because they can sabotage, inter alia, by placing an appropriate explosive near or on an underwater installation.

It is necessary to build a protective installation on pipelines and their passive protective functions, including observation and warning functions, as well as active ones, capable of "self-defense" with the appropriate use of monitoring centers. It may be futuristic, but maybe not that much. The type of protection always depends on the rank of the object and even the depth at which the underwater installation is located. Naval aviation will also be useful for observation, as well as unmanned aerial vehicles with listening devices, radars and even satellites. The case of Nord Stream 2 shows that the attack can be carried out safely with total impunity for the attacker. However, the attack required skills that only the state actor possesses.

The way to carry out such an attack is theoretically simple. After locating the installation, and it can be done, for example, under the pretext of oceanographic research, placing the explosive itself will not be difficult. Properly equipped drones will not only prove themselves, but also camouflage the charge.

Protection of the gas pipeline also means protection of the natural environment of the Baltic Sea. Therefore all countries of the basin must be involved. It can be done by the Navy, but not by itself. Safety is a multidisciplinary activity: the Police, Intelligence, Counterintelligence, Border Guard, Seismological Institutes, institutions implementing modern technologies, etc. should be involved. Specialized companies responsible for controlling the condition of underwater pipelines using drones are no longer sufficient. All these institutions need to build the resilience of this critical infra.

## Summary

Putin's war with European energy is not over yet. For years, Europe has been at the mercy of Russia's geopolitical energy blackmail. Since the Kremlin's re-invasion of Ukraine on February 24, Moscow has been keen to play the energy card in the hope of scaring Kiev away from the West and the West from Kiev. The recent Nord Stream explosions could mark a point of no return in energy relations between Russia and Europe. Russia wanted to demonstrate its ability to destroy Europe's energy infrastructure, which it is currently doing in Ukraine. Will the Nord Stream attack be one of many on Europe's energy infrastructure? The sabotage on the Nord Stream gas pipeline was Putin's warning shot. The West should prepare for the next insidious actions by Russia.

Russia is signaling to the West that it has a whole set of

unconventional tools that it can use if it continues to support Ukraine. It was a relatively inexpensive way to send a very informative signal. Russia is weakened and will rely all the more on unconventional tools. These include cyber warfare, chemical, biological and even tactical nuclear weapons and acts of sabotage.

The explosions heightened fears in Europe about the coming winter, suggesting that other critical continental energy infrastructure could also be attacked in the future, including the Baltic Pipe linking the Norwegian Continental Shelf with Denmark and Poland, which officially opened on the days when the first reports were made about problems with Nord Stream. Legal regulations are urgently needed to protect this type of infrastructure.

The sabotage against Nord Stream 2 and the war in Ukraine have shown how vulnerable the energy infrastructure is. Infrastructure stress tests should be carried out. International cooperation is needed to identify weaknesses and prepare responses to sudden disruptions. This should be accompanied by procedures to minimize the effects of spills and contamination of the environment and other high-risk sectors, such as e.g. maritime digital and electricity infrastructure.

The article does not raise the importance of the Baltic Pipe for the energy security of Europe. This may be the subject of a separate study. ■

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KUSTAA VALTONEN

# The future of Finland is well connected

Expert article • 3315

**F**inland is an island - a saying that has been repeated for a long time and for a good reason because it is true. As a discussion topic, this has even become a little humorous. Finland has invested in well-functioning ship connections and smooth flight routes, but recent years have shown brutally how vulnerable those connections can be in the face of a crisis or global pandemic. Additional connections would be welcome even for normal everyday life.

Finest Bay Area Development launched the railway tunnel project between Finland and Estonia in 2016 by conducting preliminary calculations and technical assessments with PWC, AINS Group and AFRY. Since then, the project has been systematically driven forward step by step. The project outcome once completed will be the longest undersea railway tunnel in the world. It is built by drilling, using tunnel boring machines and it is entirely underground for the whole length of 103km. To be built are two tunnel pipes, one for freight traffic and the other for passenger traffic, in addition the tunnel can host other infrastructure, such as data and energy cables. The tunnel connects two metropolitan areas into single one, reducing the current travel time from 2.5 hours to 20 minutes making the travel intra-city rather than inter-city. The Helsinki and Tallinn regions are transformed into a large common urban area that creates new and unprecedented attraction worldwide, gravity. The four stations to be built along the tunnel line will provide a new city to populate on both sides the Gulf of Finland.

The environmental impact assessment (EIA) of the tunnel was initiated in April 2019, when all countries in the Baltic Sea region, including Russia, were officially notified. The feedback has been factual and there has been no opposition to the tunnel from any country. The EIA process is coordinated by the Ministries of the Environment in both countries. The EIA has already nearly completed in Finland, having conducted various surveys and studies. In Estonia, the process has been blocked for ideological reasons, even though the project is included in the Estonian Government's government program. The opposition has mainly come from Center party and some specific companies, and the single biggest reason for this opposition has been that infrastructure such as the tunnel should not be built or owned by a private party. This ideology runs strongly against the principles of open competition in the EU and are not on a sustainable foundation.

## Strategic importance and NATO

The strategic importance of the tunnel has been emphasized by Finland's application for NATO membership. It clearly already had a defensive significance in the past, but now in the future, when the tunnel connects two NATO member states, it will rise to a whole new level. The mobility of troops and equipment is an obvious scenario. Security of supply, sabotage, intelligence and civil protection are a more complex dimension. It was easy to blow up the Nord Stream

gas pipelines and at the same time we got a glimpse of the threat picture of how easily shipping in the Baltic Sea can be stopped. The tunnel is easier to defend, and it is protected deep inside the ground. In Finland, the tunnel would be connected to the existing networks of underground facilities, of which there are lots of in the Helsinki metropolitan area. Tunnel stations can serve as civil defense shelters, especially in Tallinn, where very few shelters have been built. The benefits of a fixed link are undeniable.

Close to 90% of Finnish logistics are maritime. It would be good to have other options to balance the situation. Approximately 6700 trucks are responsible for Finland's daily logistics. Channel tunnel daily through put is 4400, the Finest Bay Area tunnel is bigger so volume that could pass through will be higher. The tunnel will make use of the Rail Baltica that is under construction even though completion date was recently pushed forward four years without any reasoning. In some thoughts, there has been a glimpse of a train connection through Sweden serving Finland. This is certainly possible in some respects, but the sad truth is that the stream of trucks passing through the north would block all roads and railways. In other words, we need more connections in terms of security of supply and lowering the risk of maritime vulnerabilities.

## Future

For the tunnel project, the next practical steps are the completion of the EIA and the application for building permits in both countries. With these, the construction of the tunnel by drilling can begin.

The tunnel will act as a driver of sustainable development and increase the attractiveness of our region globally. The future is built by young experts who create new inventions and make a better tomorrow. We live in a global competitive landscape for those smart young talents. Finland and Estonia are world leaders in education and innovation. Our startups have already created several success stories (like Supercell and Rovio) and we see a significant number more to come. The region is currently attracting more investment capital in relation to population than any other country in the world. However, we must ensure that we do not stay where we are, but that we create the conditions for the future.

A good example of a success story is the world's largest concentration of game developers in Finland, who produce about 6% of all the world's mobile games, bringing significant export revenue to our country. We are larger than our size in this field, which has come about thanks to a close-knit talent pool and a high level of education. This is exactly what we see the tunnel enabling. A new kind of attraction is emerging that attracts people here to the Finest Bay Area to study, live, innovate and start new companies, build the future. We have a world-class framework for all of this. ■

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MARTTI KIISA &amp; KARIN LELLEP

# Timber as a modern construction material

Expert article • 3316

**T**imber is nowadays used for both simple as well as architecturally and technically complex structures. The heights of timber buildings exceed 50 m and spans of roofs and bridges can be over 100 m. Timber has numerous positive but also many negative properties that must be skilfully taken into consideration when designing. The claim that timber is not a considerable construction material because it rots and burns, is outdated and distorted. Decisions regarding timber structures can be made only by those who are up to date in this field and rely on research-based knowledge.

Among the many advantages of timber, it can be emphasized that it has a relatively high strength compared to its density. Although timber is most commonly used for simple elements (columns, beams, arcs, slabs) it is also possible to construct rather complex structures such as trusses. Thanks to the continuous development of technology the selection of timber products is very diverse. The biggest contribution to the development has been made by adhesives that allows to produce elements with very big spans and special cross-sections. Engineered wood products are based on sawn timber boards (glued laminated timber, cross-laminated timber), veneers (laminated veneer lumber, plywood) and strands, chips or fibres (oriented strand board, etc). If to add here different built up (like I-beams) and composite structures (combined mostly with concrete or steel), it is clear that there are a lot of options to create modern and impressive structures. Timber structures can undoubtedly compete with almost any construction material from both the structural aspect as well as solution diversity.

When using timber as a construction material, its disadvantages must also not be disregarded. Timber as a construction material has been investigated thoroughly – scientific research on its physical properties started already more than 250 years ago. A smart approach enables to consider the special characteristics of timber and the necessary applied instructions already exist. The unique structure of wood that develops when growing is more complex than any other construction material. The main factors that need to be taken into consideration are moisture content, duration of the load to be applied and in which direction, compared to the grain, the load is applied. One of the biggest challenges has turned out to be the insufficient moisture protection of timber, but there are many constructive and chemical solutions to fix this problem. E.g., it is possible to change the properties of timber in a wide range by modifying the cell wall polymers using acetylation, furfurylation and heat treatments. The main focus of these modifications and research is to increase biological resistance and dimensional stability and also to replace toxic wood preservation chemicals like creosote, arsenic, copper and chrome. In recent years a lot of research have been carried out to develop moisture-proof timber constructions.

The second biggest challenge is the fire safety of timber buildings. It is obvious that timber is a combustible material and can be destroyed in a fire. But actually, timber burns at a relatively slow rate and in

a controlled form. A lot of effort has been put into the development of both appropriate measures as well as regulations. According to regulations and guidelines structures should limit all risks related to fire (including spread of fire, spread of fire gases, evacuation) and the safety of firemen is also taken into consideration. The most common methods to secure fire safety are adequate cross sections, sheathing, sprinklers and material modifications.

The fact that timber is the only widely used renewable construction material in the construction sector must surely be considered when making smart decisions. Approximately 4 billion hectares of land is classified as forest in the world and 25% of these forests are located in Europe. Timber is an ecologically clean material, and its use reduces the amount of CO<sub>2</sub> that is cast into the atmosphere. In addition, the manufacturing of timber products takes quite a small amount of energy and effects the environment minimally.

Timber as one of the oldest construction materials that has been used already during the stone age, is undergoing a new awakening. Although there have been considerable changes taking place for over the last quarter century, the biggest developments have above all taken place in the last decade. Timber is by far not only a finishing material anymore, but also a considerable material for load-bearing structures. It is therefore important to understand the essence of timber as a material, trying to consciously and wisely take advantage of its strengths but at the same time skilfully avoiding its weaknesses. The increasing use of timber structures is a considerable option in environmental protection and ensuring sustainability. ■

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AFONSO BRITO

# Tackling Europe's maintenance deficit

Expert article • 3317

The efficient, safe and sustainable mobility of the future will rely on the infrastructure we have already built and we are building today. While the EU has one of the densest transport infrastructure networks in the world, a large part of this infrastructure is now ageing and coming under increasing pressure due to a rise in traffic. To add to the problem, the lack of proper level of investment in maintenance has led to the deterioration of transport infrastructure. This vulnerability is no more evident than by the malfunctioning of bridges or as observed in the poor state of some road surfaces. For this reason, the **European Construction Industry Federation (FIEC)** has placed a strong focus on Europe's maintenance deficit, stressing that the continuous maintenance of existing infrastructure is vital to ensure the uniform quality of Europe's transport network and with it contributing to its economic competitiveness, increasing the safety of its users while also reaping various environmental benefits.

## A problem only getting worse

While the state of Europe's entire transport infrastructure was already worrying, its maintenance deficit has worsened over the past decade and this comes with a high cost. In Spain, for example, a reduction in resources allocated to conservation of roads over the past decade has led to a situation that will require investments of 7,5 billion Euros to reverse. Neglecting maintenance also exposes users of our transport infrastructure to a greater risk. The deterioration of rail infrastructure in France, for example, has led to the tightening of speed limits on over 5000 kilometres of tracks over safety-related concerns. While these problems are glaringly obvious, it is no less true that neglecting maintenance has significant environmental impacts, particularly, in terms of CO2 emissions, as well as raw material consumption and waste generation. The longer a structure goes without maintenance, the larger the scale of works needed to restore it to its original condition.

## Bridges in a critical state

Europe's maintenance deficit is no better illustrated than with the deterioration of bridges. As essential connecting points, the malfunction of these structures attracts particular attention. This was the case with the collapse of the Morandi Bridge in Genova (Italy), so too with the closure of Rahmede viaduct near Lüdenscheid which caused traffic chaos on one of Germany's main transport routes. The magnitude of this problem cannot be understated. In France, at least 25,000 bridges are in a critical state to the point that they constitute a risk for their users and have deficiencies in terms of usability, while in Germany thousands of bridges must be demolished and reconstructed because the repair would be too expensive. FIEC has been working to bring more awareness to this issue, hosting one of the largest conferences dedicated to bridge maintenance in Brussels back in June with another one planned for April 2023.

## A modern Trans-European Transport Network

Despite these issues, the current legal framework at the EU-level contains limited obligations on Member States in terms of maintenance. The Trans-European Transport Network (TEN-T) policy, based on the

TEN-T Regulation (No 1315/2013), is a core instrument at EU level for influencing Member States' infrastructure policies. The TEN-T is an EU-wide network of rail, inland waterways, shortsea shipping routes, and roads, connecting over 400 major cities with transport hubs and, when complete, will cut travel times between these cities.

Recognising the necessity of modernising the EU's transport system, the European Commission adopted a proposal for a TEN-T revision which comes with several important changes. It introduces more ambitious requirements for each transport mode and also more ambitious deadlines and it creates nine 'European Transport Corridors' integrating various transport modes (rail, road, waterways, etc.). But more importantly, the proposal comes with stricter provisions with respect to maintenance, a move FIEC has advocated for and welcomes. The proposed new rules oblige Member States to maintain the network's infrastructure in a way that it can provide the same level of service and safety during its lifetime.

More ambition is required to tackle Europe's maintenance deficit, one of our most pressing needs. Over the decade, maintenance of our transport infrastructure hasn't received sufficient attention. A well-developed and well-maintained infrastructure not only avoids higher costs tomorrow but also guarantees the safety of users across Europe's entire transport network and represents a key activity in the circular economy. FIEC will continue working towards this end. ■

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# The state of the public built environment in Norway

Expert article • 3318

**P**ublic buildings and infrastructure are a country's backbone. If this backbone does not work sufficiently, the consequences can be fatal for society.

It is therefore crucial to have sufficient knowledge of the conditions to determine whether the buildings and infrastructure are functional, safe and sustainable – and not least: whether it is robust enough to withstand climate change. This knowledge is often deficient, which was the situation in Norway until 2010.

Because in contrast to the Norwegian Government Pension Fund Global where we could follow the development of the fund's value with a single keystroke, there was no equivalent for the great values that generations have built up onshore. In addition, there was no cross-political agreement on how the onshore public values could be secured and managed for current and future generations, as politicians across party lines had agreed on concerning the Fund's savings.

The need for knowledge was enormous. That is why we in the Norwegian Association for Consulting Engineering Companies (RIF) chose to conduct extensive examinations on the state of the public infrastructure and in Norway. The first report was produced in 2010, and we launched the last one in 2021.

RIF sees it as our social responsibility to map and highlight the values and needs and, not least, to advise on what is needed to get the most out of public spending. Our members, the consulting engineers, have the necessary expertise to make such assessments. With this expertise comes an important responsibility, which we have chosen to take on.

## The maintenance backlog is increasing rapidly

At first glance, the weaknesses in our infrastructure and buildings may not always be seen. Many new roads and magnificent buildings have been constructed in recent years. At the same time, the deterioration of existing infrastructure and buildings has accelerated.

The findings of our research are both worrying and deterring. Since the report in 2015, maintenance needs have increased by over NOK 600 billion. As a result, the total price tag for the maintenance backlog is now above NOK 3,200 billion, corresponding to the vertiginous amount of 31.2 billion euros. Without extraordinary measures, the legacy of our generation stands at risk of becoming those who failed to take care of their own country and sent the burden of their negligence to future generations.

## Climate change makes us even more vulnerable

The extensive maintenance backlog makes Norway even more vulnerable to climate change. The latest report from the UN's climate panel (IPCC) states that climate change will lead to increasingly severe and frequent extreme weather. As early as the mid-2030s, the total greenhouse gas emissions may cause the global temperature

to exceed 1.5 degrees, which will have a vast and severe impact on our lives. It is time for us all to realise that there will be no escape, not even for Norway.

We must recognise that the consequences of climate change present society with formidable challenges. A wetter and warmer Norway with more frequent extreme weather will entail significant societal challenges and costs. Some of the damage cannot be reversed. It is, therefore, crucial to prioritise climate adaptation.

Preparing current and planned infrastructures, both above and below the ground, to cope with future weather conditions can mitigate some of the consequences of climate change. Stormwater management is an example of an invisible measure which can save us from high costs in the future. For every 10 cents invested in stormwater management, 2.5 euros will be saved in damage repair.

With ever-increasing challenges linked to climate change, increased pressure on cities and decreasing financial resources, it is crucial to take action. Climate change will change how, where and what we build. Climate adaptation requires extensive national planning and extra funding.

## Correct priorities have never been more important

31.2 billion euros. This number can appear almost unfathomably large. Even though it is naive to believe that it will ever be equal to zero, this does not mean we shall stand on the sideline and watch it grow. Instead, we need to come together to form a plan on how to prepare our nation for what is about to come. Both the consulting engineering industry and research intuitions are ready to contribute with our expertise to ensure that this happens in a sustainable way. ■



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# Grey or green?: Cement and sustainability in Germany, Poland, and Norway

Expert article • 3319

## A Stavanger perspective on cement

Cement production is an important factor for reaching higher levels of sustainability. A look at the Norwegian city of Stavanger helps to illustrate this:

From here, the operations of the Norwegian oil and gas industry are being directed. Yet the worldwide trend to renewable energy confronts the city with a paradoxical situation. On the one hand, the oil industry provides the city with the financial means, the knowledge, and the skills for developing new, greener businesses. On the other hand, Stavanger's economy remains locked in an economic legacy that is difficult to overcome.

The city's construction sector is an indicator of this in-between situation. During the oil boom, Stavanger has developed from a relatively small municipality into an industrial base. Consequently, the demand for new buildings was very high. Moreover, at the time, Condeep platforms were built at Stavanger, that is massive deep water structures made of concrete used for oil and gas extraction in the North Sea.

Today, the development of new construction projects remains important for the city's economy, with ever more and ever higher buildings being planned and built. Yet cement – the most important materials to produce concrete, second only to water – contributes to about 8% of global CO<sub>2</sub> emissions; it is thus not very difficult to see how *grey concrete* puts *green development* at Stavanger into question.

But does more concrete necessarily equal less sustainability?

## Cement and sustainability: Some concrete facts

Cement is an essential construction material in infrastructures such as pavements, bridges etc. Annually, up to 5 billion tonnes of cement are being produced worldwide. This makes the industry responsible for 7% of industrial energy use worldwide and the second industrial emitter of CO<sub>2</sub>. For example, as of 2021, German cement clinker production is the country's third-largest source of industrial greenhouse gas emissions, with 20 million metric tons of CO<sub>2</sub> equivalent annually. In many other countries, the cement industry is the main contributor of industrial CO<sub>2</sub> emission.

The cement industry therefore plays a pivotal role when exploring CO<sub>2</sub> emissions reduction options. The following options are available: i) increase energy efficiency, ii) use of alternative fuels, iii) carbon capture, storage and/or use, iv) substitution of clinker, or v) recycling of materials.

Some of these alternatives are long-established. The substitution of fossil energy and raw materials, for example, has a 40-year long tradition in the cement industry. It produces a triple win for the environment: emissions reductions, decrease of natural resource extraction, and enhancement of waste management. Yet each of these achievements has narrow limits. For example, the chemical

suitability of waste used as alternative fuel for the production of clinker represents an issue in terms of sustainability. Similarly, it is questionable whether co-processing of waste will enable the CO<sub>2</sub> reductions that are required. Therefore, newer technologies such as Carbon Capture and Storage (CCS) are currently being seen as a solution for the cement industry.

## The future of cement – experiences in Germany, Poland and Norway

Norway, Poland, and Germany are important centres for developing and testing the practices that help to improve the environmental performance of the cement industry.

Germany has a long history in the usage of waste-based raw materials and fuels. Since at least the 1970s, the German cement industry has gathered experience with the use of secondary materials in production processes, emission control, and the necessary regulations. As a result, the use of alternative fuels in the German cement industry has developed significantly, from circa 5% in the 1980s to about two thirds of total fuel energy demand. However, this includes fuels sources such as used tires and waste oil, which limits the effect on CO<sub>2</sub> emissions. In Germany, CCS is therefore being seen as a possible technical solution for achieving the ambitious CO<sub>2</sub> reduction goals. A first plant is being scheduled for 2022. But questions regarding cost-effectiveness remain. Moreover, societal acceptance is an issue as the CCS technology is controversial in Germany.

In Poland, one of Europe's most dynamic economies, the construction industry contributes significantly to the development of the national economy – in 2021 it was responsible for 6.7% of national GDP. Compared to industry production (25%) or trade and repair of vehicles (15%), this may appear low. Yet, the carbon intensity of the industry makes further decarbonisation efforts a pressing issue. In the past, the use of alternative waste fuels has increased dramatically, from about 1% at the end of the 1990s to circa 70% today. This rapid progress resulted in some insecurity regarding the stability of supply of suitable waste. Consequently, the integration of CCS in the Polish cement industry is attracting attention. For example, the EU Innovation Fund decided to co-finance the capture and storage of CO<sub>2</sub> from a cement plant in Kujawy offshore under the North Sea.

Norway could be a beneficiary of the abovementioned developments. Its expertise in co-processing, for example, is important for its relationship with emerging countries. This group of countries is currently introducing the use of alternative fuels, and therefore welcomes expertise from the outside. Moreover, Norway is a potential beneficiary of developments in Germany and Poland. The Longship project is central in that regard. In this project, CO<sub>2</sub> from industrial sites (including cement) will be liquified and permanently stored under the North Sea. It does not seem impossible

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that at some point Germany and Poland will link up to this new CO2 infrastructure. Plans for such a move already exist. Whether and how their implementation will affect construction activity in Stavanger remains to be seen. ■

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# Infrastructure as driver of a sustainable society

Expert article • 3320

Unexpected events during the past years have brought many of us re-consider the values of life. The pandemic made many people move out from the compact urban apartments back to spacious countryside, companies are struggling to find employees because people are leaving their permanent employments to work short-term and although the pandemic restrictions are over, people choose to work from home instead of going to the office. What has made these changes possible is technological development and the infrastructure. In the western countries, for example transportation-, communication-, sanitation- and energy infrastructure are well developed even in remote areas. Developed societies invest very organized in constructing and maintaining the infrastructure, and the expectation is that functioning infrastructure is provided equally to all citizens. Constructing and maintaining infrastructure is very much material- and energy intensive, meaning the harmful environmental impact can be significant. At the same time, well-functioning infrastructure has positive societal impact, and it is necessary for the economy. Majority of infrastructure projects are funded by public money, especially when it comes to transport infrastructure. Considering the sustainability targets of EU and the national, even more ambitious targets, one might think sustainability is of high priority even in the infrastructure projects.

Good infrastructure provides value to all members of the society. Thinking about the social sustainability, functioning and accessible transport infrastructure does indeed increase equality. Roads and railways enable commuting between home and work, but also going to hobbies and other activities. It enables interaction between people, meeting family and friends, giving us freedom to choose where to live, for example. Transport infrastructure is also necessary when it comes to delivering goods and services from one place to another enabling high standard of living not only in the urban, but also in rural areas. During the past year, since Russia attacked Ukraine, we have unfortunately got a reminder, that transport infrastructure may also be used in political and aggressive purposes. On the other hand, it also provides safety and security both during the good times but also through the turbulent times. Investing in the transport infrastructure is an investment that all members of the society need and can benefit of.

As good infrastructure is good for social sustainability, it is good for the economic sustainability, too. Achieving economic growth and prosperity is challenging without well operating transports and logistics. The availability of raw materials, goods, energy, labor and achievability of customers and the market are necessary for economic activity. Therefore, as described earlier about the social sustainability, the impact of good infrastructure is similar to economic sustainability. These two are highly interconnected to each other; investments in infrastructure are known to have a positive impact in economic activity and in well-being of the members of the society. Some countries, as for example Sweden, have infrastructure investment plans overarching a decade long period, because stability in the

development of infrastructure has proven to have positive effect in businesses. Sweden has certainly succeeded to develop businesses across the country, and good infrastructure plays a crucial role in that.

Although we know that sustainability is all about the balance between social, economic, and environmental sustainability, we still act like environmental sustainability is an individual function and nature an endless source for raw materials. The positive impact into two dimensions of sustainability, economic and social, has been valued over the environmental sustainability, because natural resources have provided us growth and increased wealthy for centuries. At the same time, we have come to realize that we are dependent on energy and raw materials imported from countries that do not respect human rights as we do, or that neglect the environmental impact of extracting raw materials, and in many cases both. Infrastructure, as the built environment in general, requires a lot of materials and energy to construct and maintain. The land use and resource needs of infrastructure projects requiring vast spatial areas and changing the environment permanently are challenging from environmental perspective.

Infrastructure projects, as all projects within construction, are rather strictly regulated and require an approval or authorization by authorities before start. Once the decision about a new infrastructure project has been done, the process usually continues with an environmental impact assessment, the EIA, as required by EU directive and amended in national legislation. In big projects it is typically done earlier as part of the land use planning. The EIA is a comprehensive process evaluating alternatives and their impact in the environment both during the construction phase and thereafter. To some extent, the EIA also takes social aspects into account, there is stakeholder dialogue and even economical aspect are evaluated. In the end, the EIA is a separate process that doesn't necessarily have much impact in the approval or authorization the project start requires. This means, that for example an infrastructure project that has been evaluated doing harmful impact for environment may anyway get an approval to be carried out. Evaluating socio-economic and environmental aspects is complex and depends also on the perspective; long-term positive impact may override short-term harmful impact, and national impact is often more important than local impact. Land use may therefore appear locally and especially individually unfair and unsustainable, while serving wider interest. On the other hand, decision making is very difficult, especially when it comes to infrastructure having impact that overarches for decades, and even centuries.

Sustainability aspects of constructing and maintaining infrastructure are decided already during design and tendering phase before the project start. This, in my opinion, is the reason why environmental sustainability often is considered as cost at projects. If the entrepreneur is unaware of developers/customers sustainability goals before offering a project, sustainability aspect usually become cost adding due to unpreparedness. Sustainability goals may be

requiring energy efficient machinery at project, developing a low-carbon work site, circular material approach or even life cycle approach. In the end, they all have the same target, which is reducing the harmful impact, but unless the execution is unorganized, results may be weak. If for example emissions reduction is only achieved by using renewable fuels or investing in brand new machinery, there are several problems in the approach. The first one is accepting higher cost to reduce emissions, and the second one is that no attention is paid to reduce energy consumption. Reducing emissions may be as easy as removing all unnecessary idling, planning the different phases to be executed efficiently and considering circular material flows. There are several pilots where these approaches have been tested and proved to work, but despite of that, the conventional methods are still dominant, and it is the price in the offer that is decisive. Cutting emissions by removing idling and increasing efficiency doesn't cost anything, but on the contrary.

Luckily, there are some ambitious sustainable customers out in the infrastructure market, that lead the way for sustainable development. Good examples of these are cities of Helsinki and Tampere in Finland, who have decided to develop light rail as public transport. In Tampere, the climate work in the second phase of the tramway has been incentivized. The carbon footprint was calculated before the project start and is followed-up during the project. Once the alliance that is constructing the tramway succeeds to reduce the emissions, a bonus is paid. That is much more than conventional climate accounting, making climate work a tool for management. In Helsinki, the Crown Bridges will connect the eastern island of the city to the center within couple of years with a light rail connection. This project has been decided to certify according to BREEAM Infrastructure, that is a sustainability assessment tool for infrastructure projects. Certifying such a large project will drive the entrepreneurs to find more sustainable ways of working, because the certificate is a requirement. These are just two examples of how sustainable development may be accelerated at infrastructure projects.

Recent past has forced us to think again on our approach to many things. Fossil fuel dependency has shown to be a mistake, global supply chains and dependency on another country made us vulnerable for sudden shortages and not everyone play by the same values. According to scientists, there are nine planetary boundaries we must respect so the planets' ability to prosper life remains. So far, these boundaries have remained rather invisible. Now we have seen the boundaries, and we know we must act. This requires changing the old habits and implementing new ways of working, which already exist, even within infrastructure. ■

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# The Russian invasion war will not collapse the Finnish economy, but it revealed weaknesses

Expert article • 3321

**T**he Finnish economy was in good shape at the beginning of this year. However, the full picture of the economy changed once again when Russia began their attack on Ukraine. The economy is still growing at a good pace this year, thanks to the strong performance last year and at the beginning of this year. Next year, the growth forecasts are on both sides of zero.

There is no major collapse in sight. Finland's economic dependence on Russia has decreased since the occupation of Crimea. The negative effects are reaching Finland through general uncertainty, the slowdown in European growth, high inflation, and rising interest rates.

However, economic uncertainty affects construction. The coming winter will bring about the third crisis in the construction industry within a short time. In 2020, the Covid-19 pandemic threatened to close construction sites, put urban living on hold, and caused uncertainty regarding the use of public spaces. This year, the war begun by Russia has broken supply chains and further increased costs that the pandemic had already affected.

The coming winter is once again plagued by uncertainty and a new crisis, this time related to the sufficiency of energy. Europe is heading towards a recession, which will mean that Finland's economic growth will also be temporarily halted at some point. We can no longer rely on zero interest rates and consumer confidence, which have helped us through the previous crises. The only certainty is that there will be surprises. Nevertheless, the current forecast indicates that the economy will keep growing. This is important for construction, even if next year we will only hit the mark with a surplus. In 2024, growth will once again accelerate, which gives new hope for the construction industry.

The industry will continue to grow until the end of the year due to ongoing projects and successful housing projects. Next year will initiate a decline. There is a lot of uncertainty, and many indicators of negative development. Our development forecast is therefore moderate and presumes that the inflation will decelerate and the financial market will remain operational.

As inflation has peaked during the autumn, price increases should slow down in the coming year. This will help stabilise interest rates and restore the trust of consumers who may have been alarmed by declining purchasing power and savings. Consumers should get used to the higher but still rather low interest rates. The inflation and the climbing interest rates have already affected housing prices. However, the housing market in Finland remains stable. Its development is mainly dependent on domestic developments. Sweden's problems are not Finland's problems, even though there are some opinions to the contrary. The crisis does not seem to be causing great harm to mortgage-holders. On the other hand, the weak development of existing capital stock will be a challenge for developers. For some time now, inflation has been gnawing at construction projects in an

extraordinary way from many directions.

Consumers will be tightening their purse strings for a while, but there is potential elsewhere in the economy. There are some industrial and public sector projects set to start in the spring. Infrastructure development will be weak, but some investments in the security of supply and energy self-sufficiency will be necessary at some point. Renovation will increase, as there will be a growing need for it. This means that negative consumer attitudes alone are not enough to paralyse the industry. Some uncharacteristic public sector decisions and loss of confidence in companies and especially the financial market would also be needed. Regardless of rising stress levels in the financial market, there is no indication of a new financial crisis.

The construction industry has successfully navigated exceptionally murky waters despite the constant shortage of workforce and materials. Thanks to the determination of the industry, the pandemic did not shut down worksites. Hard work and innovation have helped counteract the material shortages and rising costs caused by Russia's war of aggression in Ukraine.

Unfortunately, the war in Ukraine continues, the world is separating into blocs, and the competition for scarce resources and technological leadership is intensifying. In March, the Confederation of Finnish Construction Industries RT carried out a scenario project that outlined short-term scenarios of how the Ukraine crisis could develop in stages. The scenarios helped identify effects and risks for construction industry parties.

As a result of the immediate effects of the war, the procurement of many construction materials became difficult and their costs rose to record levels. In the spring, it was difficult to obtain binding prices and delivery times for new projects. Delivery times were stretched and companies experienced difficulties at least in fulfilling existing contracts. Making investment decisions became more difficult. Some of the projects were rescheduled when it became almost impossible to anticipate the development of costs.

The continuation of the war and the rising iron curtain on the eastern border mean a big change, and emphasise the importance of preparedness. In practical terms, it means looking west for material deliveries. Logistic routes are being reorganised and material warehousing is increasing. Production chains are shortening and operations dispersing. Local production and security of supply are becoming a part of the discussion again, but with a new perspective.

Changes in supply chains and future reconstruction in Ukraine will maintain pressure on construction costs. One of the central findings of the scenario work was that a market operating in crisis conditions requires crisis-flexible contracts. At the beginning of the war, the rise in construction costs appeared to be a problem only for the builders. In fact, the increase in costs affects all parties, both owners and workers. If construction slows down to a point where supplying the market is impossible, the entire economy as well as



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societal development will slow down. ■



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# BALTIC RIM ECONOMIES

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HARRI HAAPASALO

# Constraints of innovations in the Finnish construction industry

Expert article • 3322

The construction industry has been rather conservative in terms of innovations, business management and productivity. Naturally, economic performance analysis must be in line with industry standards. In the last five decades, the planning, design and construction processes have shown few improvements in the productivity curve in the context of the global as well as Finnish construction industry. Productivity measures output related to input. Any improvement in output is negated by cost development, resulting in a horizontal or even negative plane in the productivity curve.

One of the major barriers to innovation in the construction industry is cost-based pricing. A project-based business is often blamed for resulting cost-based pricing, which hinders the emergence of innovations. However, several industries operating in a project mode have successfully utilized value-based pricing; therefore, being a project-based business is not a problem. Cost-based pricing seldom enables investment in innovation and development. According to recent studies, companies in the construction business rarely use an intentional business model under which they either analyse, bid or choose to participate in certain types of projects. The lack of business models naturally separates projects from each other and does not enable the repetition or benefits of scales. Individual projects drive the business processes in construction, not the other way around. Individual projects, together with project-based pricing, result in a construction business following a type of prototype production and business mode in which productivity or business development is hard to ensure, irrespective of how innovative people are.

Several discussions and efforts have emphasised and enhanced innovation in different industries. There are different theories and schools of thought in favour of systematism and/or creativity. Creativity is a natural prerequisite for innovation. However, one needs to be systematic to be sustainably creative to introduce innovations in an organization. Naturally, there are some great inventions that are exceptions to this rule. In practice, this means that companies in certain businesses need to have processes that enable some level of systematism, scale of benefits and repetition. In the 1950s, Toyota noted that "decreasing variation is the source of efficiency," which cannot be achieved without defined processes. Any known quality management or excellence evaluation criteria will verify this.

Products and processes should be the focal points for continuous improvement and innovation. You need to know what, why and how to improve. In an organizational sense, the business model description should include the definition of a product (tangible, intangible or a mix of these), requiring the product development process to define the product or an offering that delivers value to customers (the entire order-delivery process) and results in revenue. The product (in construction, it is naturally configurable) is the item defining the cost. It needs to be unambiguous to enable efficient processes that accumulate costs with minimum variation. Rational innovations

should focus on the critical elements of a business model such as offering, value creation system and revenue logic.

Another factor resulting in poor productivity is the traditional contract model in the construction industry. In practice, these models limit the role of suppliers to delivering what is ordered, with no room for modification. This shifts the emphasis to the order, not delivery or collaboration. In the case of orders that are expensive and take time to deliver, the supplier should focus on "what is needed" instead of "what is requested". Supplier should be the expert of a delivery. A collaborative contract model enables this, and the early evidence indicates an optimistic output in terms of cost, quality and time.

Finland is a promised land for many new things. Generally, Finland is known as a development-oriented country led by technology leaders such as Nokia. We need to learn to apply the best practices for each industry. In the construction sector, novel collaborative contract models have gained extensive attention in the context of large and complex projects, where Finland has become the forerunner by applying collaborative contract models, resulting in a conducive environment for innovation. There are also several examples of the introduction of new technology in the construction sector, especially in the case of construction products. However, the construction industry requires structural changes and renovations to significantly increase productivity through innovations in construction. ■



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# Digitalisation is a necessity for improving productivity in the construction

Expert article • 3323

The productivity of the construction industry lag compared to other industries. While other industries have increased productivity construction sector hasn't been able to keep up the pace. Improved productivity builds up from many sources and utilizing digitalization on improving operations will have a major impact on productivity. Digitalisation itself rarely solves any problems. The benefits of digitalization are built on top of the ways of working. Therefore, it is important to evaluate and improve the ways of working while taking the advantage of digitalization.

Digital tools are widely in use for construction design, but the adoption of digital tools in construction sites remains low. The situation builds a risk of an information gap between the design and production. Practically the gap means that the information isn't where it is needed (at the site). The latest designs in the BIM model won't update themselves to the paper printed on the wall. The feedback loop from the site to the office remains slow when the digital information flow is cut. Problems remain hidden and as-built implementations won't find their way to the designs. In an ideal case, the information flows seamlessly between the project stakeholders transparently enabling fast reactions and corrections without any delay.

Digital workflow also enables data collection to support process visualization and improvements. Without data from the construction process, it is impossible to recognize and fix the problems in the ways of working. Information flow using paper forms is slow and collecting an overall picture from the different data sources is time-consuming or impossible. Therefore, the digital journey of the construction industry must start with building up the data collection capabilities and ways for information sharing. Building the data collection capabilities will lead to defining standardized processes and harmonized data structures which will enable enterprise-level data visualization.

One may claim that building standardized data structures for construction is impossible as each project is unique. Naturally, projects have their unique features. Still, each project shares similar materials, implementations and designs. The companies and industry need to find common nominators and standardize on a level which is wise for the production flow. It makes no sense to design similar details again for each project or use several installation techniques for the same task. Standardization of design and work will make all phases in the process easier to follow and control. The whole chain of construction will benefit from standardization as the standard ways of working create predictability. Design, material supply, scheduling and resourcing become less complex.

Just moving from paper-led production to digital will improve the profitability as in improved information sharing and feedback loops. The first steps of digitalization don't mean 5-D (3-D Design Schedule and Budget) production control with fully standardized processes. Simple improvements may have a significant impact on workflows and productivity. Site workers do have the devices to work with digital

tools, but the tools aren't always used actively. If the solution is difficult to use or important information isn't available digital tools remain unused. The user must get value from digitalization. Simple matters such as digitalised hourly tracking, reporting, and invoicing will speed up the work reducing the administrative task of a contractor. Tools to solve practical problems help the individual contractor to save time while standardizing the way of working. Tools can also help the contractors to build standardized offerings which will lead to fewer surprises in projects leading to better margins and time savings. Any improvement in data collection and visualization will help the individual company to learn from the data and lead the business based on facts.

After the implementation of data collection and visualisation, the individual company and industry can take full advantage of data-driven process control and improvements. Learning from data will open new areas to improve. Removing the pain points from the flow will gradually show better productivity, lower cost and better quality. Taking the control of processes and managing with digitalisation industry will take a productivity leap. Process improvements must lead the digital path. ■

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# New era for the construction industry

Expert article • 3324

The Finnish construction industry has been in repeat and optimize mode since the widespread application of prefabricated concrete elements in the 1960s. This has been challenged in large scale only twice – in the oil crisis, beginning in 1973, and after the dissolution of Soviet Union in 1991. However, the structure of the construction ecosystem has stayed pretty much the same until today. This is likely to change soon, as the market realities go through a step change and the price tag for climate change non-mitigation becomes ever more transparent.

The Finnish construction industry has just lived through one of its heydays. Annual production of apartments has been over 35.000 units in every year since 2016, with a maximum of 47.000 units in 2021. This is a lot, as the long term estimate for new build demand is slightly above 30.000 units.

The excess demand is a sum of favorable conditions. Low interest rates and ever-continuing bull market in global finance has brought the international housing funds to play a major role in remote yet stable countries like Finland. In the same time, domestic households have benefited directly of the growing share of housing company debt in financing new builds. This has lowered the investment threshold both for professionals and wannabes. As a consequence, the production of apartment houses has almost doubled from early 2010s.

Biggest booms tend to come right before busts. Yet even Covid did not cut the boom, rather the opposite - construction was one of the unlikely survivors of the epidemic. The government stimulus packages were partly channeled to second homes and buy-to-let apartments for those who did not need to fear unemployment. This amplified the phenomenon where already in 2019 more than half of new studio apartments were sold to investors.

Basic challenge in improving energy efficiency of the building stock is its very slow renewal rate. It would be nice if the boom in construction volumes had enabled a giant leap in energy efficiency, but this is not quite the case. Added insulation, improved air tightness, and three- to fourfold glazing all follow the tightening building standards and contribute to improvements in new builds. Partially the same methods, but especially renewing the old heating systems to heat pumps, do the trick when renovating older properties.

Yet the sheer number of apartments, their average size per inhabitant, as well as electrification of everything have grown at a rate that has been impossible to beat by energy savings. As a result, Finnish households' energy consumption has actually increased by 12 per cent since the year 2000.

According to an old joke, in times of trouble the contractors can't afford to develop their business – and in good times they don't have the time. Thus they never do. This would be a cynical interpretation of their low profitability, yet the numbers do suggest that something is indeed missing. Competition is fierce, that is for sure. And although a few newcomers have even made it to the stock exchange, their longevity still remains to be tested.

Interestingly, the same period of time has made the built environment design and consulting companies to continuously renew themselves. There the main driver for change has been investor money, either looking for quick market share for Nordic companies or a path for growth and exit for private equity. Until now the results have

been somewhat more promising than with contractors.

Some design companies have been able to leverage this by developing new products and services that cater to new needs and new clientele. These vary from complex urban planning software to using data in predictive real estate management. Simultaneously parts of design work have been simplified and automated by algorithmic software at drafting stage. Overarching themes have been digitalization and sustainability. These resonate well with the biggest challenge of our time: the multidisciplinary push for net zero carbon.

Design and consulting companies have less fixed assets and laws of nature to worry about, so they are not directly comparable to the hard realities of contractors. Yet it is obvious that both fixed and fluid approaches are needed as the sector moves to its next phase. New carbon emission mitigation measures will inevitably change the way that the construction sector is expected and allowed to operate from now on.

Luckily for the Finns, it seems that the challenge can be coded to engineering language. As consensus on mitigation's key performance indicators and schedules develop, they can be used as such in building information models and also to develop contract models, regulations and laws. All these are currently in motion. And all this brings the contractors, designers and consultants closer to the client, as well each other. It is likely that in climate change mitigation and innovation Finland will play a role that is way bigger than one would have expected. ■



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KAISA PIRKOLA &amp; PETRI HEINO

# Promotion of wood construction in Finland

Expert article • 3325

**T**he construction sector has plenty of opportunities to mitigate climate change. Emissions from construction can be easily reduced by using renewable materials, such as wood. In addition to renewability, wood has many good qualities as a construction material: it is light, loadbearing and insulating. It is also easy to process and easier to recycle than many other materials.

In the Programme of Prime Minister Marin's Government, Finland set the objective of increasing the use of wood in construction. At the same time, the aim is to increase the value added of wood products and to find more diverse uses for wood and wood fibres. From the climate perspective, there is a particular emphasis on wood products where carbon is sequestered for a long time.

The promotion of the use of wood in construction and of wood products serves many of the current policy objectives in Finland. In addition to climate change mitigation, these important objectives include sustainable construction and housing and promoting the circular economy. As wood raw material is mostly of domestic origin, the harvesting and processing of wood have positive impacts on the vitality of rural areas.

## Important developments seen in wood construction in recent years

Traditionally, wood has been widely used in the construction of single-family houses in Finland. In recent years, remarkable progress has been made especially in multi-storey construction and large wood constructions. The use of wood in public buildings has increased substantially. For example, a large number of wooden schools and daycare centres have been built in recent years. This has even been called "a boom of wooden schools". The Finnish construction sector has truly proven that a transition towards low-carbon construction and housing is possible.

Although we have long traditions in wood construction in Finland, increasing the use of renewable materials is still important, and so is improving its cost-effectiveness. This means that further product development is still needed concerning e.g. the even wiser use of side-streams, the reuse and recycling of materials, and the development of low-carbon fibre-based insulation materials. The key objective is building performance related to matters such as technical durability, fire resistance and energy efficiency with minimal environmental impact. And, of course, we must not forget architecture and user satisfaction. The main goal is to have healthy and enjoyable buildings for us to live and work in.

## Increasing share of wood in construction set as goal in several strategies

The most important strategy for promoting wood construction in Finland is the Wood Building Programme (2016–2023) led by the Ministry of the Environment. The objectives of the programme are to

promote and develop the skills base in order to take wood construction onto an internationally competitive level and to support industrial wood material manufacturing in Finland. As part of the programme, in 2020 national targets were set for the share of wood in all new public construction and for the types of buildings with the greatest construction volumes. The programme also promotes new industrial solutions for large wood constructions, such as bridges and halls. One of the key objectives of the programme is to boost exports.

The discussion on increasing wood construction often focuses on multi-storey buildings and public construction. This is understandable, because they have the greatest potential if we look at the construction volumes. In addition to the measures of the above-mentioned Wood Building Programme, the Ministry of Agriculture and Forestry also promotes the use of wood in construction. Development work on wooden farm structures and transport infrastructure is carried out as part of the Catch the Carbon programme launched in 2020.

Wood is highlighted as a climate-friendly material, so it is also justified to develop methods for estimating the amount of carbon sequestered in wood, including tools for the assessment of the carbon footprint and handprint in wood construction projects. In addition, the two ministries have jointly funded communication projects related to forest carbon sequestration and the carbon storage of wood products. The scale of construction projects has increased and the methods are partly new, so efforts are made to enhance expertise in the sector by producing learning materials on wood structures and wood products. Topics that still need to be further studied include the impact of wood buildings and wood materials on indoor air, acoustics and health, and on how people experience wooden spaces.

Cooperation at the European level is also considered important, including exchange of information about best practices related to wood construction. Many countries have just recently decided to participate in the WoodPop initiative and the New European Bauhaus initiative, and Finland is actively involved in both of them. Although wood construction has long traditions in Europe, we believe that even this sector will still see innovative solutions, materials and applications of using wood. ■

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MIIKKA KOTILAINEN &amp; MARI KOTILAINEN

# From wood waste into wood art

Expert article • 3326

**A** small Finnish woodworking company on a mission to make wood worth gold \*\*

When I founded our woodworking company Puuartisti (Woodartist Ltd.) 8 years ago, my dream was to design and manufacture only unique pieces of carefully crafted furniture. Ultra high quality and no compromises when it comes to details. If only I could find enough clients to make my own living, I would be happy – not an easy task in the field of woodworking, claimed as one of the “sunset industries” where most struggle with profitability.

Obviously I knew the grim facts: finding the right kind of customers would be challenging, because many Finnish people choose mass-produced throwaway furniture and don't even consider investing in higher-quality items. Many don't really seem to value wood, either: we live surrounded by vast forests, so trees are just mass: they grow, are sawn, processed and burnt for energy.

So there I was, a young man in my 20's – with not much else than a dream and a small workshop. First I made a few dining tables, until I managed to land the most significant deal so far: the whole interior of a local restaurant. We were looking for extremely rustic material for the wall panels and tabletops, and I managed to find almost 100 year old reclaimed wood that had been dismantled from an old log drivers' cabin. The material goes back to the days when logs were transported via waterways, and the workers needed places to rest along the rivers: the planks used to serve as the walls and floors of one of these cottages, and they were weather-worn and covered with all sorts of carvings by these loggers – even bullet holes.

That really struck me.

The wood had “lived” through intriguing times and such naturally worn material could not be fabricated – the beauty of it was irreplicable. I realized what our mission was: that I didn't want any trees to be felled for our products; that I wanted to show the beauty of unique reclaimed and waste wood materials in ultra-finished and carefully designed wood installations – the types that people couldn't even imagine. Pieces of modern furniture that would always feature something new. And I started digging.

We found trees that had been felled in a park in our neighboring city of Joensuu. Piles of hard-to-find trees such as bigger rowans or poplars, both species with particularly beautiful grain patterns when used in furniture. All going to the energy plant, and the local people were outraged. We wrote down stories about the trees and their past, and shared them with our followers on social media.

When the years passed, our projects grew. In 2018 we landed a project that would truly showcase our mission. We got the chance to design and manufacture the sauna interior to the headquarters of the multi-billion video gaming company Supercell. I became pickier in terms of raw materials, so I dug deeper. The material that I chose to use in that specific sauna is something that is never used in the woodworking industry: we collected 100 storm-felled spruce trees from which we would use the leftovers, the roots. The natural curve in the roots would form the actual curve of the sauna bench, so the person in the sauna would sit “on the root”.

We documented the spruce root project from the start to finish. Our social media audience had grown quite a lot and yet again we were astonished by how interested people were about a project they would probably never see with their own eyes, and how inspired they were about the fact that such beautiful design could be made from raw material that was considered pure mass for energy production.

The root sauna gained a lot of nation-wide attention and media coverage, and we have continued our experiments. We found tree trunks that had sat underwater for dozens of years and made a sauna interior out of them. At the moment we are making a table from pieces of wood that have been excavated from peatlands. The wood has sat there in the wetland for centuries and now end up in a dining table for the next hundreds of years.

But does it matter that a small company like us has big aspirations to increase the valuation of wood if we only make 1-3 projects in a year? Obviously the problem is that our work cannot be scaled. The number of manhours in each of our latest projects is calculated in thousands, so we can't really help with the overproduction of meaningless furniture on a larger scale.

What we can do is communicate. We document all projects thoroughly and publish them in social media, and constantly hear the “wow, I wish I had the chance to buy something like that – I don't, but I'll find the old coffee table that my grandad bought and have it repaired, since it's solid wood and can actually be repaired.”

Now I have succeeded in making my own living and employing a few others, as well, but what really measures our success is whether we actually can produce value to both our clients and the wider audience. To inspire people to value things that last. Since we need our trees growing. ■



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# Finnish construction export changes its form

Expert article • 3327

Last fall, I sat for the second time on the jury, which selects a construction project completed or to be completed during the current year as the building project of the year. Finnish Association of Civil Engineers, RIL ry. awards the annual RIL award to the construction work, site or concept that best represents high-class, high-quality and innovative Finnish civil engineering skills. The award was solemnly handed out at Helsinki's Säätytalo on November 24, and MP Elina Valtonen, who acted as the chief judge, announced Espoo's Blominmäki wastewater treatment plant as the winner of the RIL award. Overall, it is rightly said to be the most significant public sector investment for decades to protect Baltic Sea's environment. It was noteworthy in the distribution of the awards that an honorable mention was given to the spectacular bridge with its arched pylons over the Saigon River built in Ho Chi Minh City in Vietnam and designed in Finland. The award was a recognition of Finnish export of construction know-how and design in 2022.

RIL Ry (Finnish Association of Civil Engineers) has now awarded the recognition for the 50th time. For export projects in the construction industry, winners in previous years have been, for example, the conference palace built by the Finns in Baghdad, the capital of Iraq (1986) and the mining town built by the Soviet Union in Kostamus (1986).

Construction exports by Finnish companies have been relatively quiet since the end of the project export boom. In the 1960s and 1970s, construction was Finland's most international industry. There were significant project exports to the former Soviet Union as well as to the Arab countries of the Middle East. Over the decades, Finnish builders have made huge profits and also deep financial losses in project exports to the world.

The collapse of the Soviet Union put an end to the barter trade, where the construction industry association, Finn-Stroi Oy, had implemented large construction projects in the 1970s and 1980s, such as the Kostamus project, the Svetogorsk paper mill, and the Viipuri pulp and paper mill. Eight major Finnish construction companies of the time were shareholders in Finn-Stroi. According to sources, the share of construction exports in the trade between Finland and the Soviet Union was at its highest around ten percent. In bilateral trade, it was also possible for work to be exported from a high-cost country, Finland, to a low-cost country like Soviet Union. The collapse of the Soviet Union in 1991 and the preceding end of bilateral trade collapsed the activities of Finnish builders in the eastern neighbor.

Russia kept the export builders busy since then. YIT, SRV, Lemminkäinen and small house builders like Finndomo and Honka continued their construction exports in the 2000s. Russia's aggressions and attacks on Georgia and Ukraine and the sanctions, that followed, put an end to the construction activities of Finnish companies in Russia.

On April 28, 2022, the construction company SRV announced, that due to the war and the market situation caused by it, it had written

down almost all of its holdings in Russia from its balance sheet. SRV had operated the shopping centers it had built in Russia. Write-downs totaled EUR 141.2 million.

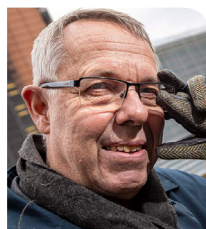
Morality, ethics and environmental sustainability are emerging trends in construction. An arms factory built for Libyan dictator-colonel Muammar Gaddafi, apartments built for the Nigerian military junta, or the construction of a military village for the Russian army near the Finnish border in Alakurtti would no longer be business-as-usual for Finland's construction industry or export policy.

Pace building, alliance know-how, utilization of algorithms and data models shorten construction time, improve productivity on construction sites and help to stay within set schedules and budgets. Increasing productivity has been a challenge in construction for decades. There are always changes at the construction site. The site runs on partnerships and networks. The old goal of making it ready at once, has not been an easy goal to achieve – even now.

The Thu Thien 2 -bridge over the Saigon River, based on Finnish bridge design and awarded with RIL's honorable mention, is an example of Finnish bridge know-how and advanced technology. The main designer of the bridge is engineering consulting firm WSP Finland Oy, which has also been responsible for the bridge's architectural and structural design. Bridge export is the export of high-tech design and service rather than the construction itself. In the bridge built in Vietnam, the same data model concept and instructions have been used as in the bridges built in Finland. The bridge over the Saigon River is impressive with its 110 meter high arched pylons. Its shape is peculiar, but its solution is optimal. When the climate changes to strong wind conditions, rising water levels and erosion, you have to be prepared.

Planning and the utilization of data models are the export of Finnish construction know-how today. ■

*The author is a member of the jury of the yearly construction engineering reward given by Finnish Association of Civil Engineers, RIL ry.*



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# Resilience of regional water services

Expert article • 3328

**M**any countries and societies are under severe stress due to unsecure energy supplies. Problems with energy supplies are influencing many critically important societal services. For local authorities these problems have now become concrete. Sustainable, high quality and safe solutions for maintaining water services have been a central focus in the Turku region for many years. Today, with more than ten years of experience the City of Turku can present a water management model that is energy positive. The water management in Turku is situated mainly underground in safe and stable conditions. This water management model is transferable and attractive for other countries and societies that wish to end the dependence of fossil fuels.

The water management model is operated by two companies: Turku Region Water Ltd and Turku Region Wastewater Treatment Plant Ltd are wholesale companies owned by the municipalities in the Turku economic region. These companies offer efficient and high-quality water supply services for the 300,000 residents and industries in the Turku economic region. These companies use strategic and operational measures to secure the continuity of water supply, even in exceptional circumstances.

## Sustainable and resilient drinking water production

Turku Region Water Ltd produces zero emission energy from the drinking water production. The artificially infiltrated groundwater produced, is pipelined by gravitation from the managed aquifer recharge (MAR) plant into underground reservoirs in the Turku area. The turbine slowing down the flow of drinking water produces most of the electricity needed for the UV-disinfection and for the pumping from the bedrock reservoirs to consumers. The electricity produced by the turbine can be compared to the energy needed for 100 houses of 4 person households or 1000 flats of 2 person households.

In addition, a solar panel system has been connected to the Turku Region Water pre-treatment plant. The pre-treatment plant is the most energy consuming unit in the water production system and the solar panel system, which includes over 1300 panels, produces part of the energy needed.

- *"We ensure a sustainable and ecological water production and delivery. In fact, our production capacity can respond to a bigger demand in the future. The production of artificially recharged groundwater requires only a fraction of the chemicals used in traditional drinking water facilities. It enhances the natural yield of groundwater without any negative impact on water quality or the natural flow of groundwater"* states Aki Artimo, CEO of Turku Region Water Ltd.

The MAR method is part of a multi-barrier system, which prevents the contamination of drinking water from source to tap. The MAR plant and other vital parts of the systems are also equipped with backup power generators. In case the MAR plant would be out of order, a backup waterworks plant is set in action.

- *"We are constantly developing the system and strengthening our resilience. We are also happy of the recognition in the book "Managing Aquifer Recharge – A Showcase for Resilience and Sustainability" published by Unesco 30.11.2021, which highlights that the MAR plant has been planned honoring the sustainability of nature with best available technology, and that the quality of the water we*

*produce is rated among the best in the world."* adds Aki Artimo.

## Energy efficient and carbon footprint reducing wastewater treatment services

The Turku Region Wastewater Treatment Plant Ltd. is operating the underground Kakolanmäki treatment plant which runs in stable conditions throughout the year. The company develops its operations based on risk management as a continuous process. Moreover, the company takes into account the carbon footprint as well as the lifecycle of the operation, which in turn supports climate resilience. Resources are optimized considering economic, ecologic and quality resources, while securing the maintenance in all conditions.

The heat of the wastewater is utilized in cooperation with the local energy company for district heating and district cooling. Municipal sewage sludge is utilized as a source for liquefied biogas (LBG) and the nutrients are recycled for recovery. In addition, the treatment plant produced its own energy by making use of e.g. heat recovery, turbines and solar panels.

- *"Additionally important is that the wastewater is treated to a very high standard, which promotes the wellbeing of the Baltic Sea"*, says Mirva Levomäki, CEO of Turku Region Wastewater Treatment Plant Ltd.

The carbon footprint of the wastewater treatment plant, including the utilization of sludge in the biogas plant and the utilization of thermal energy of wastewater, is negative, i.e. beyond carbon neutral. For the moment, the treatment plant complex produces about ten times more energy than it consumes. District heating and cooling systems benefit from the energy surplus of wastewater treatment. ■



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# How cities enable Denmark's green transition

Expert article • 3329

Cities are home to over half of the world's population. As such, they are hotspots of the impacts and risks that climate change has brought about. But they also hold a crucial part of the solution. Through years of experience, Denmark has made cities one of its strongholds and key enablers of green transition.

Creating liveable cities means taking a holistic approach through public-private partnerships and cross-sector collaboration. When implementing urban development projects, the concern for the environment, the people and the businesses must go hand in hand. Looking at Denmark, the notion of public-private climate action has proven fruitful in especially three areas. Namely blue infrastructure, energy-efficient buildings and biking.

## Working together on water

From floods to water scarcity, water crises linked to climate change are among the biggest threats to our cities. In 2011, Copenhagen was hit by an extreme cloudburst, where rainfall was measured at up to 200mm in the hardest-hit places. In the end, the damages amounted to costs around EUR 1.6 billion, making it the most expensive natural disaster in Europe that year. The event proved to be a watershed moment for how Danish cities approach water-related challenges and heighten the importance of an integrated approach to climate change adaptation, urban development, and water management.

Now, instead of viewing rainwater as something to dispose of and hide in sewers, most Danish cities combine underground solutions with green surface solutions that utilise the water to enhance the lives of their citizens. Cities such as Odense, Viborg, and Copenhagen, have adopted long-term integrated plans for climate change adaptation, where creating climate-resilient cities also entails heightening liveability.

Building upon a long tradition of facilitating dialogue between public and private, Danish learnings show that a key puzzle piece in realising ambitions on water for greener cities is an inclusive approach to stakeholder involvement. As every conceivable part of society is affected by how we manage water challenges, the best solutions emerge when all voices are heard - from city authorities and utilities to companies and citizens.

## Benefits of bettering buildings

As buildings account for almost 40% of global energy consumption, they represent a pressing but promising element in the green transition. Promoting energy-efficient buildings has long been a cornerstone of Denmark's green ambitions, and Danish cities are leading the way.

Cities like Sønderborg, recently labelled "the energy efficiency capital of the world", have launched initiatives targeting energy-inefficient buildings. They range from educating craftsmen in energy consultancy and guiding homeowners through renovation projects, to introducing accessible financing models and coordinating

communication amongst stakeholders in the building and renovation market. Such initiatives have led to increased enthusiasm about investing in energy renovation for both homeowners and public authorities with large building portfolios. In Sønderborg, 60% of homeowners that received guidance subsequently invested an average of EUR 20,150 in energy renovations.

Crucially, the efforts of Danish cities have shown that pursuing energy efficiency in our buildings is not just about lowering emissions and energy demand. There are also great economic and social benefits to be reaped. By creating green, efficient and healthy buildings, we can make the urban built environment more sustainable across the triple bottom line.

## Bicycling across borders

In Denmark, we have over 100 years of experience in planning for bicycle traffic in and around our cities. Today, 9/10 Danes own a bicycle, and cycling accounts for more than a quarter of trips under five kilometers. Every day, Copenhageners bike a distance equivalent to 35 times around the globe.

This has led Copenhagen and 30 surrounding municipalities to jointly invest in so-called "bicycle superhighways". A cycle superhighway is a cycle track, where the needs of the two-wheeled commuters have been given the highest priority. 10 bicycle superhighways have already been established, and the aim is to have 60 routes covering more than 850 kilometers nationally.

Collaboration across regions and municipalities on improved bicycle infrastructure is a yet great example of the Danish tradition of enabling broad dialogue that leads to tangible solutions. Finally, it highlights the fact that no city is an island.

Climate change does not know borders, and neither should climate action. If we are to realise the immense potential of our cities to drive the green transition, we must pursue international cooperation and learn from each other wherever possible.

From happy cyclists to green constructions, I hope that Danish learnings may help other cities find solutions to the common climate challenges we all face. ■



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MANTAS MAKULAVICIUS

# Mineral materials and aggregates in the Baltics

Expert article • 3330

**M**ineral materials and aggregates used in transport infrastructure, construction or any other purposes importance is undeniable. Its usage and extraction not only benefits economics and social environment, but also should be sustainable. Socio-economic activities such as increasing housing, infrastructure demand and manufacturing sector has guided the growing demand for non-energy mineral resources. There are over 50,000 mines around the world in which approximately 200 types of mineral resources are in use. Based by European Aggregates Industry data the European aggregates sector represents 15,000 companies (mostly SMEs) operating through 26,000 sites, with over 200,000 employees. Aggregates are the second most used natural materials worldwide, only after water, and consequently are the biggest mining branch by production volume. For example, the European average aggregates demand is 6 tons per capita per year, meaning the use of 1 Kg of aggregates per hour.

By definition, aggregates are inert material, while primary aggregates are produced from natural sources extracted from quarries and gravel pits and in some countries from sea-dredged materials (marine aggregates). Secondary aggregates are recycled aggregates derive from reprocessing materials previously used in construction, demolition residues and by-products from other industrial processes. There are currently no viable alternatives to the large-scale use of aggregates in construction. Aggregates are the core building material in all our homes, offices, social buildings, and infrastructures: without aggregates these would literally fall apart. The construction of a typical new home uses up to 400 tons of aggregates (both end product and concrete) - from the foundations through to the roof tiles. Aggregates are used to build schools, hospitals, museums and other social or public buildings. An end-product in themselves as railway ballast, armor stones, beach replenishment, aggregates are also raw materials used in the manufacture of other vital construction products such as ready mixed concrete (made of 80% aggregates), pre-cast concrete products, and asphalt products (made of 95% aggregates).

Since aggregates are mostly mineral materials extracted from the nature, it's reasonable to investigate current situation of Baltic states geological treasures and its reserves. Based by Lithuanian Geological survey data, 17 kinds of mineral reserves/resources have been explored to various degree of detail in **Lithuania**. Ten of these (limestone, dolomite, sand, gravel, clay, chalky marl, peat, sapropel, opoka and oil) are under exploitation. Dolomite beds in Lithuania are detected in many geological systems, but only dolomite deposits occurring near the land surface in the northern part of Lithuania are considered to be of a practical significance. There are some inland oil drills, but the production and resources are quite small compared to oil rich countries. There is valuable resources of anhydrite as well, but it is not being extracted so far. Due to geographical placement of Lithuania, there is no opportunity to extract granite aggregates according to economical rationality. So it must be kept in mind, that

igneous rocks are imported to Lithuania as to all the other Baltic countries.

The subterranean depths of **Latvia** are rich in the resources of various mineral materials that can be used to produce construction materials: the resources of sand and sand-gravel, dolomite, clay, limestone, gypsum rock, peat, and sapropel are widely available. The principal mineral found in Latvia is limestone, with an approximated reserve of 6 billion cubic meters. Limestone is mainly used as a raw material for cement and concrete. The reserves are sufficient enough to provide 85% of the raw material for its cement industry. The deposits are spread throughout the country and occur at fairly shallow depths. Gypsum rock is also among the most valuable land resources, Latvia provides this resource to all the Baltic States. Dolomite, in turn, is a widely spread mineral resource and presents a major source of mechanically resistant stone materials. Thirty the most important deposits of gypsum rock, limestone, dolomite, clay, quartz sand, gravel, sand, stone, and sapropel are included in the list of mineral deposits of national importance.

Furthermost in **Estonia**, 944 various sized deposits (incl. oil shale, peat, crystalline rocks, gravel, sand, clay, dolostone, limestone, phosphorite, sea mud) are registered. The kukersite oil shale is the most important mineral resource in Estonia. At present, of the total 10–12 million tons mined per year, slightly over 80% is burnt directly in thermal power plants as pulverized fossil fuel. The chemical industry uses about 15% of the mined oil shale for oil recovery, and about 3% goes to the cement industry. The Estonian deposit is the largest commercially exploited oil shale deposit in the world; its total reserves exceed 7 billion tons of oil shale. Other mineral materials include more than 900 sand and gravel deposits for road and industrial building, clay deposits, used mainly as a raw material in the ceramics and cement industries. Resources of limestone are used as a raw material in producing lime, cement and building stone, but also in glass, chemical, pulp and paper industries. Dolomite is suitable for glass and finishing stones, used in the chemical industry and as road and industrial building material.

While analyzing each of the Baltic country, it can be stated that geology among them is similar with some exceptions. There is no very expensive mineral materials, but the area is resourceful for aggregates used in transport infrastructure and construction. Usage of aggregates is a function of the state of a national economy: Together with the growth of the economy, the demand for sand, gravel, and crushed stone increases, as they are essential for infrastructural development and commercial and domestic building activities. With the upcoming big projects such as the Rail Baltica, usage and extraction of mineral materials and aggregates will definitely increase. We all just have to think about most economical way to extract and use our natural treasures in the most sustainable way. ■

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Expert article • 3330



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# BALTIC RIM ECONOMIES

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ALARI PURJU

# Perspectives of the Estonian construction sector

Expert article • 3331

The construction sector could be treated as a broad cluster type collection of different activities or as a narrow construction sector focusing on building houses and civil engineering objects. The broad construction sector covers the narrow construction, the real estate activities, the manufacturing of construction materials and the architectural and engineering activities subsectors. The value added at factor prices of the broad construction sector in Estonia amounted to 5.7 billion euro or approximately 21% of Estonia's total value added in 2021. The real estate subsector with 49% of the value added of the broad construction sector was the largest producer of value added, followed by the narrow construction with 32%, manufacturing of construction materials with 14% and architectural and engineering activities with 5%. The productivity in value added per employee in the real estate activities subsector was more than two times higher than in other subsectors, meaning that provision of services related to valuation, marketing and sales of assets was substantially more productive than production of new real estate assets. The total number of employees in the broad construction sector has been around 90000 or 13% of total active labor force of Estonia. In terms of hired labor force, the number of employees is largest in the narrow construction sector with 50000 people working in the subsector.

In the broad construction sector, the most international subsector is the manufacturing of construction materials, the most important products being concrete, crushed limestone, precast concrete products, metallic doors, windows and constructions, plastic pipes, foam isolation products, wooden doors and constructions etc. Exports created approximately one third of the output of that subsector. In traditional construction sector, exports contributed approximately 5% of the total output. Finland and Sweden are the main exports markets for manufactured construction materials and construction works. The architectural and engineering activities subsector has been highly innovative and relatively effective, but most of the bureaus are relatively small and that strangles their international competitiveness.

During the recent years, the output of construction sector fluctuated a lot. There was some decline due to COVID-19 related restrictions in 2020. All subsectors started to grow again from quarter II of 2021 and that growth continued into 2022. The quarterly growth figures were more than 10% higher in comparison with the respective quarter of the year earlier. The rapid growth of volumes and prices at the real estate market accompanied increase in the construction subsector. However, in summer 2022, the growth stopped and for the second half of 2022 the forecasts and business sentiments in the sector are quite sober. Representatives of companies in the sector considered the main obstacle for growth being rapid increase of costs of different materials used in the sector. The increasing labor costs are an important factor to hinder construction. Demand in exports market also showed marks of decline.

In the near future, the sector would meet important challenges. The construction of Estonia's part of the Rail Baltic railway and infrastructure is one of those challenges. The project has been delayed and there are still problems related to its realization. It demands approximately 300 million euro annually (the total estimated cost of Estonia's part of the Rail Baltic is 1.6 billion euros), which is approximately 10% of the narrow construction sector's total capacity. The large project creates opportunities not only for Estonia's construction companies but also for manufacturing of construction materials and architectural and engineering activities. The real estate sector is interested in this project because terminals under construction will be also trading places and perspective passengers will create additional demand for different services other than transportation.

The National Spatial Plan Estonia 2030+ envisages wider perspectives of Estonia's construction sector. The strategy sets actions and initiatives involving both the public and private sector, including upskilling of the labor force, fostering use of ICT tools and leveraging public procurement as a tool to digitize the construction sector. The vision is that Estonia's construction sector would be environmentally sustainable and efficient, fortified with the new technological solutions. At the same time, Estonia's various future projects rely heavily on the EU funding and follow supply side approach. In several aspects, they do not take into account the demand side, self-financing capacities and willingness of consumers to pay. Estonia has not managed to construct 2+2 highway between its major cities Tallinn and Tartu, Pärnu and Narva. The countries with historically lower GDP per capita than Estonia today have managed to realize such kind of projects in the past. To use road tolls or other financial tools to create finances for road construction is not a very popular idea among the Estonian politicians. ■



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# Energy infrastructure innovation from Estonia

Expert article • 3332

Europeans have lived a very comfortable life by being one of the richest continents and one of the biggest consumers in the world. The damage from this fossil based old economy has deepened to the extent that The European Parliament declared a climate and environmental emergency in 2019, urging all EU countries to commit to net zero greenhouse gas emissions by 2050. Today it is estimated that roughly 75% of EU emissions are generated from the use of fossil-based energy. The electrification of our economy is now on full speed, both on the energy production and consumption side. EU member states have set ambitious goals in this and so has Estonia. We have constantly exceeded our renewable energy goals and in 2022 our government officially set a very ambitious target to reach 100% renewable electricity consumption by 2030.

The success of rolling out solar and wind parks on land is now being followed with large scale offshore wind farms deployment. In the 2022 The Estonian Maritime Spatial Plan was approved, and the country is now fully geared up to kick-start large scale wind energy production on the seas as well. With all that capacity securely planned and ready, another easily reachable goal has been agreed: to become the largest producer of wind energy per capita in the world.

The electrification is one of the biggest infrastructures overhauls a nation can have. Because of the vast scale and cost of it, the electrification of our economies needs a deep dive in the technology innovation and fast. Governments can initiate a lot here with subsidies, tax breaks or by just being a role model. For example, more than ten years ago Estonian government established the world's first nationwide electric vehicle fast-charging network and developed the smartest and most innovative energy distribution grid. That was achieved by a very good public and private sector collaboration both with foreign and local companies.

In partnership of the government, local IT software companies Codeborne and Net Group, nationwide grid operators and Swedish foreign investor Ericsson who has around 500 R&D staff in Estonia, the joint world leading grid innovation was completed from R&D to roll-out in an extremely short time. Another great example is how freshly established drone startup Hepta emerged from local accelerator and government opened its nationwide power line infrastructure for their fast-track R&D. As a result, they now have one of the best power lines inspection and analysis drones in the world and by now have exported this technology to nearly 20 countries in less than 4 years.

These are great examples of how international cooperation and openness from both public and private sector can bring very quick innovation and climate goal wins. It is crucial for private and public sector to offer their infrastructure to researchers, scientist, and engineers as a sandbox of novel solutions. I believe Estonia as a R&D sandbox has nailed it quite well and can be a role model for other EU countries with its agile, open, transparent, and progressive environment for such innovations. We should all seek more of that

type of open collaboration both locally and internationally and join efforts in this common environmental challenge.

Shortly there will be a third electricity grid connection built between Finland and Estonia to calm price fluctuations and increase energy trade with Scandinavia. But basic hardware investments are not enough. Estonians have acknowledged that we cannot just focus on lowering our local carbon footprint with old or foreign technologies. We must also take responsibility and leadership role in the technological R&D as well. With those needs we have taken a third clear goal in this green transition: to become the top greentech development center in the world.

There is great evidence that we can really achieve that because there is already a lot to offer to the world. Our local tech scene includes Elcogen that is the most advanced fuel cell producer with the highest rate of energy conversion efficiency in the world and Skeleton Technologies that is the global leader in ultracapacitor and supercapacitor energy storage systems. There is great innovation ecosystem to support it such as Estonian based European center of excellence for energy technologies, world's first nationwide hydrogen valley or the emerging offshore wind tech port hubs.

We are aware that becoming a technology leader in any field is very ambitions, but I believe that in this climate crisis when our house is on fire, we should all try to champion the greentech innovation as well as possible. We are all together in this great challenge of green transition and I believe collaborating and uniting the efforts is the key. By being open, flexible, collaborative and ambitions towards this common goal of electrification we can really achieve the EU green goals and be a role model for the rest of the world. ■

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OLGA FELDMANE

# The diverse role of the construction industry in economic development of Latvia

Expert article • 3333

**W**hen measuring the role of a certain industry in the overall economy of a country, we usually consider different statistical indicators, e.g. industry turnover, number of employees, number of acting companies, export volumes, value added.

In Latvia, as most probably in any other country, construction industry constitutes an important part of the economy. Construction industry turnover in recent years grew steadily, mirroring stable development. Stability was not shattered even during the first year of Covid-19 pandemic, despite of the global turbulence and ruptures faced all over the world. In 2021 and 2022 Latvian construction industry experienced essential decrease, which might be a short-term consequence of Russian military aggression in Ukraine or might be an evidence of more deep recession. Statistical data for 9 months of this year show approximately 12% decrease in construction industry turnover. In order to understand the real effect the decrease may cause, we need to understand the true role of construction industry in economic development and percept how deeply it permeates processes.

First of all construction industry is a genuine mirror of the country's economic development pace. Any complications or problems faced by business, or lack of confidence within the society, will be reflected in the construction indicators. The Covid-19 pandemic clearly demonstrated this inextricable connection. When pandemic hit Europe, and despite the fact that construction sector in Latvia was one of the less influenced, industry signalized of the immediate impact, predicting approximately 30% decrease in production. Also less noticeable fluctuations within the construction industry may be the evidence of more global problems. Proper analysis of the fluctuations of the volumes of construction, can help to draw objective conclusions regarding the true state of the economy and identify actions needed in order to facilitate economic development.

Secondly, construction industry is quite suitable for "heating the economy". It interacts with the wide range of other industries, forming essential financial flows and making the business work. During economic recession, public investments in infrastructure may perform as a trigger that launches a purposeful chain reaction and activates connected industries with a spider web effect. In 2020, the government of Latvia injected additional investments of around 500 million euros in *high readiness* public infrastructure projects, in order to propel economic processes.

And last but not least, construction is a key instrument for the evolution of living environment and development of any other industry. Productivity, competence and abilities of the construction industry, as well as the administrative procedures related to the construction processes directly influence the decisions of any other business on making investments. This is more true within the common market of the European union where we are free to switch from one country to

another, investing money in necessary structures in countries with the most favorable circumstances. Surely the decision on where to invest is based on various considerations, such as tax policy, availability and qualification of labor force, availability of resources necessary for the business, logistics solutions, however the "maturity" of the construction industry is of fundamental importance as well as the state imposed administrative procedures. In case of Latvia, where there are strong connections with the neighboring countries and similar business environment, the level of development of construction industry and the level of bureaucracy of administrative procedures may prove to be decisive.

When evaluating or rating investment environment, first of all we consider transparency, simplicity, costs and time consumption of the administrative procedures. Though these are of a high value, the level of development of construction industry is essential. Competent and qualified performance of each party of the construction process helps to reduce significantly risks faced by the owner, e.g. inconsistencies and defects of the building, violations of deadlines, inability to fulfill obligations. When deciding what country to give the priority for investments, mature, competent, responsible, modern and technologically developed construction industry will be one of the basic factors that will influence the decision making process.

Undoubtedly, the government through a targeted and purposeful policy should establish competitive processes for the development of real estate. Likewise, governmental policy may facilitate the establishment of the mature construction industry. The construction policy in Latvia during the past few years was directed towards strengthening responsible and competent construction industry. ■

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IVI ANNA BUCE

# Mission Latvia: An alternative for investments in Asia

Expert article • 3334

It is already clear that according to stock market index ratings, 2022 will be the worst year in the last ten years. According to *Standard and Poor's* (S&P 500), the decline could reach 17%, roughly half the decline experienced by stock markets during the 2008 global financial crisis. Many tech companies continue to lay off their employees, with the most prominent examples being *Meta* and *Twitter*. A similar trend can be observed in Israel, which is a technologically advanced country. However, the situation is not the same everywhere and the Baltic states, including Latvia, have shown significant growth in attracting investment in recent years. This is largely due to the changes in global supply chains caused by the pandemic, as well as the continued availability of highly skilled professionals in the Baltic states and the reasonable costs of running a business.

## Open for Smart Investments

According to the data of the *EY Attractiveness Survey Europe*, last year Latvia ranked fifth in Europe in terms of the number of new jobs per million inhabitants created by foreign investment projects, while Estonia was fourth and Lithuania – sixth. On the other hand, according to the number of new projects per million inhabitants, Latvia ranks 10th in Europe, while Lithuania is 11th, and Estonia – 24th.

Latvia, like the other Baltic states, has worked hard in recent years to improve the investment environment. Here are some examples of what has been done in Latvia. We have defined the investment priorities, and these are smart specialisation areas, covering sectors such as biomedicine, smart energy and mobility, photonics and smart materials, bioeconomy, IT, smart energy, and business service centres. Of the 32 investment projects handled by the Investment and Development Agency of Latvia in 2021, 25 were in these sectors.

Digitalisation and automation, as well as investment in research and development, are key to business competitiveness. A study by the Bank of Latvia and the Organisation for Economic Co-operation and Development (OECD) has found that companies that use state aid opportunities are about 30% more resilient in export markets than those that do everything on their own. Therefore, we provide a wide range of support tools for companies that see opportunities for their development in Latvia, starting with various types of training programmes such as *Agile*, *Prince*, *Scrum* and ending with digitisation vouchers, where small and medium-sized companies can raise up to 100 000 euros to co-finance their projects. At the same time, there is also a large investment programme, which can raise up to 10 million euros in the form of a capital discount. More about support opportunities in Latvia at [investinlatvia.org](https://investinlatvia.org).

## Energy Victory March

We are aware that so-called **smart** investments are easy to move, therefore we work equally carefully with those investors who are already in Latvia, offering proactive after-sales service. After Latvia's strategic shift in investment attraction, focusing on projects with

higher added value, we have seen a rapid increase in interest from investors who want to develop science-intensive manufacturing and smart energy projects in Latvia. Industries focusing on biomedicine, electric car development, solar and wind energy projects are developing. A particularly vivid example is the offshore wind project *ELWIND*, which we are developing together with Estonia. It will be one of the first transnational projects of its kind in Europe. LIAA will carry out all the necessary preliminary work, including environmental impact assessments, to put this wind farm, which will be located approximately 16 km from the shore, up for public auction. It will not only be an energy project, but also a stimulus for the development of other related sectors. After the start of hostilities in Ukraine, energy is one of the hottest topics in Europe. It is also particularly relevant for us in two aspects – to ensure energy independence from Russia and to meet the EU's common climate goals. *ELWIND* is expected to generate around 20% of the energy consumed jointly by Latvia and Estonia. Of LIAA's portfolio of investment projects worth more than a billion, about two-thirds are related to energy.

## Latvia – New Nordics

Many Nordic companies see the Baltic states as their home market. Latvian companies operate on a similar model. We try to adopt good practices and offer our own solutions. Latvia's business environment is very flexible, and the size of the country allows us to quickly see what works and what does not. In a way, we are a testing ground, which is especially important for technology companies to check the viability of their products or services.

Latvia's national image strategy is based on a mission-driven approach, which means that we want to focus knowledge and resources to achieve more ambitious goals. We want to double our export volume and our investment in research and development between now and 2027. These are ambitious goals, which is why smart investment is a key focus. Today the world is changing rapidly, manufacturing is returning from Asia to Europe, and Latvia is a great place to develop your projects! ■



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# Residential construction development in Lithuania

Expert article • 3335

Lithuania's residential construction market took a long way to become as modern as it is now. In 1990 Lithuania gained its independence from the Soviet Union. At this time the residential market was not developed, and housing stock consisted mainly of urban Soviet housing estates: high-rise prefabricated apartment buildings (mostly 5–12 storeys), working-class dormitories and rural settlements. Privatization, restitution and land reforms have been carried out, and residents acquired their rights to ownership of the housing. By the end of 1998, Lithuania's housing stock consisted of 1,306,061 housing units, on average 353 units per 1000 inhabitants. Most of these dwellings were situated in prefabricated high-rise buildings with low energy efficiency, neglected maintenance and repair and poor technical infrastructure. Moreover, serious housing shortages were observed.

In 2004 Lithuania became a full-fledged member of the European Union. Lithuania gained more than 10 billion euros in financial aid, which has boosted economic growth and created jobs. Economic development positively influenced the construction sector and enforced development of modern residential construction projects. In 2005–2008 construction sector was one of the most developing industry branches in Lithuania. The main reasons for this rapid development were growth of national industry, good credit terms, possibilities given by EU Structural Funds, higher demand for residential buildings, increasing supply of new building materials and technologies.

The situation changed dramatically in 2009, when construction sector decline reached more than 60% due to global financial crisis. Over this period, financial institutions stopped credit lines for almost all real estate development projects. During the next two years, real estate development was financed mainly by the state and businesses' own financial resources. The construction business had skipped their investment plans in residential real estate development projects due to the decreasing demand of their products and services.

From 2011 situation has changed to positive. Lithuania slightly recovered from the crisis. In ten years (2011–2021), 107,250 new dwellings (in individual and multifamily houses) were built. New developments were encouraged by the growth of the economy, low interest rates followed by increasing demand for housing and development of rental market, especially in the capital Vilnius.

The COVID-19 pandemic also had impacts on residential market developments. Within the quarantine period, interest in real estate not only remained but was also higher than before, and demand for semi-detached, individual houses, homesteads and apartments in the seaside has increased. Being close to nature became a new value for households.

There was a growing trend to incorporate sustainability and energy saving strategies into individual and multifamily residential construction projects. Directive 2010/31/EU and the national calculation of cost-optimal levels of minimum energy performance

requirements have been transposed into Lithuanian laws so that Lithuania is on track toward implementing relevant requirements. The minimum energy performance class of new buildings and building units is being progressively tightened towards NZEB based on the energy efficiency classes, i.e., from 2021 the energy performance class must be at least A++.

Residential real estate developers and architects are searching for sustainable construction solutions, which are necessary due to climate change, saving on expensive energy costs and reducing the carbon footprint. Residents' interest in ecology and appreciation of sustainable architecture and construction is increasing. People are looking for quality housing and a healthy living environment and are willing to pay more for an apartment in a sustainable building. European Green Deal is expected to encourage building with local natural building materials, for instance, timber. Discussions about the construction of high-rise residential timber buildings have already started.

It can be concluded that the residential construction market developed very fast in recent years and residents of Lithuania now have a wide choice of modern housing. However, current geopolitical situation, war in Ukraine, increased costs of living, energy and construction materials, and interest rates will negatively impact housing affordability. According to the Centre of Registers, real estate transactions in Lithuania have slumped 18% on the year so far, and the gloom can extend well into 2023. On the other hand, if activities in the new residential building market will slow down, housing stock can be improved by renovating existing buildings. ■

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NIKITA LISITSYN

# Construction sector in St. Petersburg: On the verge of a crisis

Expert article • 3336

**C**onstruction sector of St. Petersburg in the last 5-year period accounted for almost 5% of the region's economy. However, it was a basement for real estate services sector, which took nearly a 10% share of the City's GRP and created demand for a large spectrum of construction-related sub-industries, e.g. production of bricks, concrete, metal constructions, etc. Its general impact on the economy of St. Petersburg might be assessed as almost one-fifth of the region's total output.

Stagnation of Russian economy since 2014 influenced the construction sector of St. Petersburg, as all other industries within the country. Construction boom in the region observed in 2000-ies had been over by 2014. But some minor improvements took place prior to year 2018 with its sport events, and in 2020 due to state program of lowering mortgage rates aimed at boosting construction sales and supporting the real estate sector in general. This program helped many regional construction companies to survive during the pandemic, despite the reduction of consumer demand as potential buyers became less inclined to buy apartments and houses in more turbulent situation.

But this stagnant performance in construction and real estate sectors was broken down after the launch of military operation in Ukraine and the huge impact of sanctions, which were imposed immediately after February 2022. In January-October 2022 construction sector of St. Petersburg contracted by 4.7% year-on-year, as the regional statistical authority Petrostat has reported recently. However, this comparatively slight overall decrease hides the accelerating process of recession in construction, as the abovementioned statistics includes the first quarter of year 2022 which was quite successful for this sector of economy. In addition to that the construction sector (and the real estate market) seems to maintain a long-term reserve of inertia. Construction and real estate projects have long-term nature, and the present impact might become more visible in 2023.

Residential real estate market, being closer to the consumers, presently shows a dramatic 55% decline of consumer demand, if compared to its average approximated figure in 2021. This fall was, for instance, reported by Alexei Popov from analytical service of Russia's biggest real estate marketplace CIAN. Representatives of construction companies draw a more moderate picture of this demand crisis, speaking about a demand decrease between 15% and 30%. However, construction companies usually tend to soften their assessment of negative trends in order to support the demand. Beside more optimistic rhetoric, many of these construction companies have launched incredibly aggressive marketing programs, including, for example, their "special" mortgages with 0.1% interest rate, which is far below the minimal interest rate set by Bank of Russia. These "special" mortgage programs have already attracted attention of the country's main financial regulator, namely the Bank of Russia. Elvira Nabiullina, the chief of Russia's Central Bank, has already expressed

her concern about this type of mortgage programs, calling these support instruments "a delusion for consumers" due to hidden price manipulations and commissions initially installed in such "special" programs. For reference, the key rate announced by the Russia's Central Bank for November 2022 was 7.5%.

Another market stimulating mechanism was installed in Russia much earlier, in the first half of the pandemic year of 2020. This mechanism offers state-subsidized "preferential" mortgages with the rate below 7% for certain categories of residential real estate (only primary market and low-cost apartments or houses). In other words, this state-driven mechanism was focused at mass-market, which suffered dramatically under the circumstances of pandemic and lowering consumer incomes. Despite its temporarily positive impact on construction sector in St. Petersburg and other cities of Russia, the result was an almost 20% real estate price jump, which devaluated its intended benefits for the consumers enjoying comparatively affordable mortgage rate (the market mortgage rates in Russia seldom fall below 10%).

All the aforementioned "special" and "preferential" mortgage programs failed to solve the two main problems of demand in construction and real estate sectors in Russia in general and in St. Petersburg in particular: constantly deteriorating consumer incomes and comparatively high costs of borrowing money in Russian economy. Thus, to prevent creation of a typical market bubble in the real estate sector, Bank of Russia as a chief financial regulator in the country announced its intention to terminate both types of mortgage programs by the end of year 2022. This would lead to further decreasing of solvent demand in this sector and to consequent fall of real estate prices in St. Petersburg. These prices have already started to decline in the second half of 2022: according to local experts, the average reduction of real estate prices in St. Petersburg already accounts for minus 10% compared to their maximum reached in the first quarter of 2022. However, the construction lobby at both regional and federal levels continues to seek for additional stimulus for the sector under review. Despite these attempts any new supportive programs can do nothing with the two basic trends in demand mentioned above: contraction of real disposable incomes and high actual price for loans.

The approaching crisis in the construction sector might have been compensated by non-residential construction. However, the long-term policy of relocating industrial enterprises out of St. Petersburg makes this option irrelevant today. Even infrastructural projects in regional economy mostly depend on residential needs and creation of new residential areas in St. Petersburg. ■



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# Wise methods for reducing CO2 in construction

Expert article • 3337

The construction and real estate sectors are called great polluters: great amounts of energy and virgin raw materials, both sustainable and non-sustainable will be consumed every year. At the same time, the industry produces a lot of waste. This should be fiction by the year 2040. IPCC, SBTi and CRREM trendlines show that the consumption levels should decrease by nearly 70% by 2040 to follow the reduction pathways limiting global warming to 1.5°C or 2°C. At the same time, other environmental aspects should also be considered, like biodiversity including eutrophication and acidification. How will that be possible?

Most of the Baltic Sea countries are members of the European Union. EU has published and updated EU taxonomy, and energy, construction and, waste directives to strengthen commitments to green transition and reduction of GHG emissions. The transition toward a greener future has been finally launched. In addition, a lot of international and EU-level standardization work is in progress to get common rules for enterprises. In the construction sector, the improvement projects will concern e.g. digital UpToDate data flows, IoT, BIM, data management and storage, simulations, energy and ESG reports. On the other hand, different construction methods will be considered in diminishing GHG emissions at the grass root level. The effectiveness in reductions is higher if focused on sources that produce most of the GHG: construction materials, site, assembly methods and place, and energy use.

The construction project will start by considering the needs and objectives of a complete project. If the new building could be replaced by modifying an existing real estate, up to 60% of carbon emissions from construction materials could be avoided. In addition, a site does not need carbon-intensive excavation and infrastructure work. However, it is essential to pay attention to demolition methods, waste logistics and processing. Up to 65% of the demolition emissions can be diminished by reusing the materials, shortening transportation distances, and using biofuels and green electricity. The other advantage of conversion projects or updating the existing building is improvements in energy efficiency and savings in energy consumption.

Energy sources, energy use at the site, and logistics are hot topics now. Shortening the project time and reducing the lost time by optimization and JOT delivery systems is relevant, especially in wintertime due to extreme weather conditions and heating at the site. In addition, it is possible to diminish energy-related emissions by up to 80% in construction and maintenance. For example, in Helsinki, Finland, up to 70 000 square meters of heated office space without relevant use produce approximately 1,8 million CO2kg emissions per year. Superfluous emissions are avoided by modifying existing buildings for more relevant use.

Whether the project is a modification or a new building, the emissions can be diminished by choosing wisely construction materials and the place from which the materials and construction

elements shall transport to the site. The EU green transition supports the reuse, recovery, and circulation of construction materials. Hitherto, the national legislation has not been flexible enough for dismantled products and materials in Finland. The overall problem is in the acceptability and eligibility of reusable products: the process needs time, patience, and resources. However, there are great examples of new construction designs which have used dismantled products.

In addition to circularity, choosing materials having a significantly lower carbon footprint can diminish the carbon footprint of a whole project by up to 40%. Carbon footprints exist in verified LCA calculations, like CO2 databases, Environmental Product Declarations (EPD), and other verified sources. I dare to say that most of the construction product manufacturers that have not compiled EPDs have only a hint of the actual emissions of the value chain. The sad truth is that under one per cent of the product lines have gone through the examination globally. Therefore, accurate data is hard to get. In addition to carbon footprint, the EPD provides reliable information on other environmental indicators, which is important for a holistic perspective. EPD information should be required in every construction project!

All the emission sources and improvement possibilities must be recognized along the value chain to gain emission reduction targets. This needs changes in processes, measurement accuracy, and attitudes. Automation in processing and producing data will be needed to get constant information. Finally, all the environmental information and data should be constantly and wisely exploited alongside economic information in strategic and operational decision-making. Think bold and brave, require up-to-date data! ■



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# Optimizing the whole life carbon of buildings

Expert article • 3338

**S**ustainability has been a hot topic in the construction and real estate industry for several years. The industry has joint investors, constructors, and legislators in working towards a lower carbon construction and real estate market. Most major market players have net-zero carbon targets but are lacking a definition for what this means on a building project level.

Traditionally the environmental impact of construction projects has been seen to largely be a result of the energy consumption of buildings. Though energy consumption does create a massive amount of greenhouse gases, we have come to notice that more and more attention should be placed on the embodied carbon of construction products. In modern energy efficient buildings over half of life lifecycle emissions might be produced before the building is even taken into use. That's why it is key to also focus on the emissions resulting from the production of construction materials and of the construction sites themselves. These are called embodied emissions.

Building emissions should always be evaluated as a lifecycle assessment. The calculation of emissions should begin with the sourcing of natural materials, run through the construction product industry and construction sites into the energy consumption of buildings and finally the recycling of demolition waste. There are generally accepted systems for analyzing such lifecycle emissions such as the EN Standard EN15978 and the EU Commission's Levels framework. Whole life carbon analysis has also been included in most of the major environmental certifications used in real estate projects. The certifications are voluntary but are more of a rule than an exception in the commercial real estate investment market.

A trend can be seen throughout the Nordic countries, and more recently also in the Baltics, to regulate the life cycle emissions of construction. Life cycle emissions would be regulated as a part of the building permit process similarly as energy efficiency has been done for several years. Legislation is in place already the Netherlands, France, Sweden and Denmark and is being developed also in Finland, Norway and Estonia in the near future. But what is the impact of such legislation?

## Current legislative framework

The more carbon intensive construction materials are included in carbon trading schemes such as the European Emission Trading Scheme (ETS). This includes cement, which is the main source of emissions in concrete, steel, aluminum and the like. As the price of the trading scheme has increased the industry has focused on energy efficiency and removing fossil-based energy from the value chain. However, many materials are fossil-based themselves and by focusing on energy consumption alone only so much can be done to decrease emissions. As a result, the industry has been working towards creating low cement concrete, recycling steel and aluminum, and more recently low carbon steel production. These materials are still in piloting phase and can be expensive for regular construction

projects.

The energy efficiency of buildings is also widely regulated in Europe through EU legislation as well as national guidance. There are specific energy consumption limits for building types as well as energy certificate type guidance which works towards ensuring the selection of sustainable energy sources. In addition, energy production is included in the ETS, making fossil-based energy less attractive.

With such measures in place, why is whole life carbon legislation still relevant? Firstly, current legislation does not cover for all emissions of a construction project: certain materials and processes are omitted from the ETS. It is also important to note that it is not enough just to lower the emissions of energy or material production, it is also important to focus on energy and material efficiency in the project. A significant amount of emissions could be decreased if material usage in building projects was optimized. This is where whole life carbon legislation steps in.

## How to ensure sustainable construction moving on?

As mentioned, several countries around the Baltic Sea are in the process of creating or have applied whole life carbon legislation. However, the legislative scope differs from country to another as does the level of impact. It is paramount that the results be comparable independently of the expert producing the evaluation: evaluations should be done by certified experts, a specific direction for the scope of evaluations and assumptions must be implemented and a thorough investigation of usable data must be executed. Industry professionals should be taken in to provide data on their products and to make sure assumptions made are an indication of industry practice.

A recent study found that while undertaking the process of creating new whole life carbon legislation one should focus on four aspects: early involvement, a wide scope including entire value chain, setting limit values that push innovation as well as allowing markets to produce additional third party verified data on better performing building products. It is not enough for developers to optimize the mass of structures; product manufacturers must also be able to compete in the race towards net-zero. ■

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# Should we calculate carbon handprint alongside carbon footprint?

Expert article • 3339

Measuring carbon footprint to show the negative climate impacts caused by business activities has become mainstream in both large and small companies. Alongside this development, the concept of carbon handprint has begun to evolve to meet the need to describe the positive effects generated by individuals, companies, and other actors. Carbon handprint aims at capturing the positive climate impacts that a company produces to its' clients or to the society at large through its' products and services.

Over the past 15 years, the concept of handprint has been developed simultaneously by several parties. One generally recognized definition of handprint does not however exist and so far, there are significant differences in defining it. One of the clearest differing views is related to how the actor's own footprint and handprint relate to each other: some researchers accept that the reductions in the actor's own footprint can be included in the actor's handprint, and some clearly distinguish the reductions in the actor's own footprint from the handprint benefit produced by the actor.

One of the clearest definitions and delineations that emerged from our study was

*"A handprint refers to the beneficial environmental impacts that organisations can achieve and communicate by offering products and services that reduce the footprints of others. A carbon handprint is the reduction of the carbon footprint of others."*

When examining various studies, both clear similarities and differences were found regarding the nature, purpose, need and mechanisms of the handprint. The literature emphasized converging views on the main reasons for the need for a handprint: bringing a positive, agency-oriented perspective alongside a negative perspective focused on disadvantages, the opportunity created by the handprint to scale the actor's positive societal impacts, and the potential of the handprint as a strategic tool guiding the company's operations. In addition, especially in the newer publications, the need to further develop the concept of handprint and to systematize thinking related to handprint and its parallel concepts was strongly emphasized.

However, the literature review also highlighted clearly differing views, as well as issues that only some of the researchers raised. In addition to the above-mentioned discussion whether the reduction of the actor's own footprint can be included in the actor's handprint, researchers have asked whether the actions that generate the

handprint should be voluntary and intentional or does the motivation that triggers the actions make any difference. There are also a variety of questions regarding especially handprint calculations that still call for clarification.

One calculation challenge is related to whether the collective nature of the handprint benefits can or should somehow be considered. The creation of a handprint is rarely, if ever, a result of the actions of only one actor. In addition, it is possible to produce a collective handprint benefit with the help of several actors, and reasonably claim that the benefit would not have occurred if even one actor had been left out.

Quantitatively, the challenge is to determine the actor's share of the handprint, while taking into account all synergies, trade-offs between different impact categories and the risks of double counting. In qualitative terms, allocation is about who should be rewarded and what kind of actions are thus encouraged to be taken by the actors. While the possibility for the quantitative division of a handprint among all actors in a value chain has been discussed in some studies, in practice, making such a mutually agreed division may not be feasible or possible. For this reason, it is particularly important for the actors to identify what part of the avoided emissions or carbon removals belong to the entire value chain, to determine their own weight in the generation of avoided emissions or removals and only claim handprint benefit from actions where their role has been essential.

Another significant calculation challenge is related to the determination of the baseline. The baseline is used in the generally accepted comparative calculation method, in which the emission benefit of a product or service is compared to the benefit generated by the corresponding reference solution. In comparative calculation, the handprint is created as the difference between the footprints of these two solutions. The advantage of the comparative calculation method is that when using a well-chosen baseline, innovations are rewarded and, on the other hand, it is not possible to create a handprint by acting in accordance with the baseline alone. The choice of baseline plays a major role in the calculation; A loosely defined baseline increases the size of the handprint unjustifiably.

The studies also highlighted the need to consider possible trade-off impacts for other environmental impact categories and other dimensions of sustainable development apart from the environmental impact category under consideration. The so-called rebound effect also came to the fore: it should be noted that in some cases a decrease in one carbon footprint may lead to an increase in the carbon footprint of another. In addition, previous studies highlighted that the fact that a handprint can be calculated for a product or a service, is not in itself a guarantee of the overall ethicality, acceptability or necessity of a product or a service. The existence of a positive handprint does not eliminate the need to reduce the actor's, product's, or service's own footprint.

As a result of the literature review, it was found that there is demand for a tool such as handprint thinking alongside footprint

1 Pajula, T., Vatanen, S., Behm, K., Grönman, K., Lakanen, L., Kasurinen, H., & Soukka, R. (2021). Carbon handprint guide: V. 2.0 Applicable for environmental handprint. VTT Technical Research Centre of Finland.  
<[https://publications.vtt.fi/julkaisut/muut/2021/Carbon\\_handprint\\_guide\\_2021.pdf](https://publications.vtt.fi/julkaisut/muut/2021/Carbon_handprint_guide_2021.pdf)>

thinking that only focuses on the negative effects of operations. With the help of handprint thinking, companies can measure and scale the positive impacts of their operations and strategically steer their operations towards solving big, global problems. However, in the current operating context with a growing number and variety of different environmental claims, for the handprint to evolve into a widespread and widely accepted concept, harmonization and development of the definitions, concepts, calculation methods and communication practices are required. Now the calculation methods still leave the actors room for interpretation, for example, regarding the assumptions, boundaries, and limitations used in the calculation. This emphasizes the importance of transparency, clarity, and openness in result communication. It is important to deliver the result communication in a manner that also enables the wider audience to get a full grasp on what products or services the handprint exactly contains and how it has been calculated.

At its best, equipped with openness and transparency, handprint thinking has significant potential to serve as a strategic indicator and a tool for creating added value in customer relationships. In addition, positive approach makes improvement opportunities visible and provides encouragement in the face of global challenges such as climate change, water crisis, and biodiversity loss. ■

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# Geothermal energy is an effective way to achieve climate targets

Expert article • 3340

**E**nergy for heating and cooling buildings accounts for a significant share of energy demand and is one of the largest sources of emissions across Europe.

In Finland, for example, the heating of buildings consumes a quarter of all energy use and accounts for almost a fifth of all emissions. In Germany, the share of heating energy is even higher, around 30% of all energy, with almost a fifth of the country's emissions arising from the heating of buildings, mostly with natural gas.

In most countries, the vast majority of heating energy is still produced by combustion. In Finland, combustion-based energy production accounts for at least 70% of heating in buildings. Only about 16% of heating energy is produced by heat pump energy, including geothermal energy. In the future, the number of heat pumps is expected to grow rapidly, up to five million units per year in Europe.

I believe that the transition away from fossil fuels – and eventually from other forms of combustion-based energy production – is bound to happen. But if Europe wants to be carbon neutral by 2050, we need a much faster pace than today.

That is why all eyes are now turning to geoenergy, or geothermal heating and cooling.

In its primary form, geoenergy is emission-free, self-sufficient and affordable. Production is steady and the energy will not run out. In addition to heating, building-specific systems can be used to cool and recycle energy, improving energy efficiency. Systems such as BTES and ATES, in which energy is stored in bedrock or groundwater bodies, can be used to address the power demand problem caused by annual cyclical variation.

Replacing old building heating systems with zero-emission geothermal energy makes sense now more than ever, as it is one of the most effective ways to reduce emissions from this sector. Although large-scale renovation poses its own challenges, the EU Commission estimates that investments in clean energy will pay for themselves in reduced energy costs. At the same time, the green transition will boost the construction sector and create new jobs, especially for SMEs.

It can be said that the potential of geothermal energy to meet the EU's climate targets is significant.

EU countries have increasingly started to support the green transition, including the switch to geothermal energy. Germany, for example, plans to invest around €3 billion in the coming years to promote carbon neutrality in district heating networks. The aim is to strengthen the role of geoenergy and heat pump solutions in particular.

For property owners, the green transition is first and foremost an opportunity to reduce risks and introduce self-sufficient clean energy heating systems in all kinds of buildings, large and small. Russia's war of aggression has shown in very concrete terms why energy independence is essential for us. Among other things, it provides us with protection against market price volatility.

We should bear in mind that it is not enough to switch to zero emission energy. To ensure the rapid uptake and sufficiency of renewables for as many people as possible, we must also reduce energy consumption. Suitable energy efficiency measures can be used to significantly reduce the energy consumption in buildings, saving not only energy but also money.

The Nordic countries have long been among the world leaders in improving the energy efficiency of buildings. In continental Europe, where the climate is milder and energy has been cheaper, there has been less interest in efficiency measures. The need for change has become more urgent with climate targets and the pursuit of energy independence. At EU level, improving the energy efficiency of buildings has long been a key objective and means of reducing greenhouse gas emissions. For example, increased building insulation and forced ventilation with heat recovery are concrete ways not only to improve the indoor climate of a building, but also to ensure that energy is not wasted.

At the same time, the energy consumption of each property and the appropriate solutions should be considered not only on a property-by-property basis, but also as a whole. The more extensively a property is upgraded, for example by combining geothermal heating with solar energy, waste heat recovery or other energy recycling measures, the more energy-optimised and self-sufficient the property becomes.

Geothermal energy is an opportunity to be seized at any time, but especially now.



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# Sustainable construction: Dream or reality

Expert article • 3341

**N**owadays, the principles of sustainability are becoming more relevant in the construction industry and are becoming an integral part of its development. Sustainable construction relies on complex solutions that increase the efficiency of buildings by reducing the consumption of energy, water and other natural resources. It also aims at minimising the use of materials and energy, reducing the negative impact on human and environment during the construction, management and demolition cycle of the building. Sustainability is not just one or a couple of processes in the course of building construction. The principles of sustainability apply from the idea of design to the end of a building's lifecycle.

Fundamentally, the structure is built to be man-friendly and environmentally friendly throughout its lifecycle. The construction cost of sustainable buildings often tends to be higher than the widely-used cheaper solutions, but investment pays off in the long-term period. In line with the principles of energy efficient construction, building operation and maintenance costs are reduced, added value is increased and economic indicators of the building lifecycle are improved.

Generally, building sustainability assessment tools evaluate the buildings sustainability level through the aggregation of the building performance in a group of sustainability indicators, such as environmental, social and economic indicators. The selection of indicators was performed considering the following aspects:

1. All indicators with a subjective assessment were excluded;
2. All indicators whose performance cannot be changed by design options or whose assessment goes beyond the building boundaries were excluded;
3. All indicators whose performance was difficult to translate into economic terms were excluded.

A common building sustainability level assessment framework has not yet been established. I would like to point out these indicators – Renewable or Non-Renewable Primary Energy / Greenhouse Gases Emission / Water Consumption / Materials-Embodied Energy / Reused and Recycled Materials / Responsible Sourcing of Materials / Waste Production / Indoor Air Quality / Lightning / Thermal Comfort / Acoustic Comfort / Integrated Design Project / Life Cycle Costs.

Although the construction sector has so far focused mainly on energy efficiency and improvement of buildings in response to climate change issues, it is not only the energy consumed during the lifetime of buildings that generates greenhouse gas emissions. About a third of the emissions from construction comes directly from material extraction, production of construction materials, construction process, renovation and demolition. This is the result of a linear economy that transforms raw natural resources into products, then throws away and destroys them.

On the other hand, the future construction strategy must be based on specific principles. Firstly, buildings should be preserved and maintained as long as possible. When a building is no longer able to perform its function, the ways to adapt the building have to be searched for. Only when adaptation is no longer possible, the dismantling of the building and reusing of the dismantled materials or elements can be considered. If reuse is not possible, the materials should be recycled to create new, high-quality materials. Similar principles apply to the construction of new buildings. If it is not possible to find an existing building that can be adapted to current needs, adaptation to other possible future needs shall be considered already during the process of new building construction. It should be possible to dismantle the new building and reuse materials and construction elements.

Considering, the outlined principles, it is possible to propose eight general conditions that promote sustainable construction development:

1. The principles of circular economy and sustainable building design are applicable to all the parties involved in the value chain;
2. When making construction decisions, total life cycle costs, financial and non-financial return on investment should be considered;
3. There must be a viable business model at each stage of the sustainable building value chain;
4. The principles should be applied with regard to proportionality: the benefits should be higher than the costs;
5. Better knowledge of construction methods is required to promote deconstruction and increase building durability and adaptability;
6. The building durability depends on building design quality, improved performance of construction products and information sharing;
7. It is necessary to develop innovative design approach, avoiding premature demolition of buildings;
8. The choice of products and systems must be determined by the possibility of reuse, repair or recycle.

This is the way how we could measure progress and success, as well as changes in government policies, such as employment rates, environmental quality, and social wellbeing. Each of us can help create a more sustainable economy by making small changes in our everyday lives. For example, we can recycle more, drive less, and eat organic foods. But sustainability is not just about individual choices; it's also about working together to create systemic changes. Whether sustainable construction will become a reality, and when it happens, is a question for every one of us. Only the cooperation of the whole society can help us achieve that our children, grandchildren and future generations have the possibility to live in a world equal to the one we live in today. ■

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NANI PAJUNEN &amp; JESSICA KARHU

# The built environment sector is ready to take a step towards carbon neutral circular economy society

Expert article • 3342

**A**t present, we face challenges whose outcomes extend beyond one geographical area or state or a single organization. The transition towards sustainability and a carbon neutral circular economy needs a systemic change in the current structure of society and the global economy. There is a need to rethink how our society works in the future and how to make changes at every level and in every sector of society. The solutions for tackling a variety of problems need innovations generated in the chain and networks in collaboration between different sectors of society and the large scale of professionals.

Regarding the construction industry, the consequences of the crisis are already visible – floods, heat waves, and shortages of sand and water are tangible issues already in many places. What we do need are solutions – how to do systemic change at the local and global levels, from the strategies of corporations to the operational level as well. In addition, we need more incentives to accelerate the sustainability transition while crossing possible obstacles in cooperation with the private and public sectors.

In the future, 75% of the population will live in the cities. Already now around half of our natural resources are consumed by the building and construction sectors. How we plan and build the areas where we live is vital for a sustainable future - is it even possible to use carbon neutral circular economy solutions in our daily lives? In practice, this means how to plan areas, design products, develop new materials in a new way, new kinds of competitive tendering processes and procurements, operations on the construction site, and so on. The key idea is to rethink everything and to integrate life cycle thinking in every part of the built environment sector's actions and the sectors linked to it.

In the European Union, we have an encouraging environmental policy and legislation, which promotes a circular economy. However, concrete effects will only be achieved through implementation. In addition, there is no worldwide legislation, so the only way to achieve global sustainability targets is via the private sector and trade. Therefore, it is important to encourage and support the private sector to develop circular economy solutions and business activity for the market. Also, it is reasonable to support and prioritize profitable circular economy business cases already on the market. Through the global value nets, there is a huge opportunity to make a giant leap towards a sustainable future.

In the book "Circular economy in the built environment", there is a list of the next steps needed on the construction industry's way towards sustainability and carbon neutral circular economy society:

## The building phase – before the decision to build, rethink and consider

- *Forecast.* Before you start, rethink everything – every phase of the project. What can you do differently in a more

environmentally friendly way?;

- *Efficient use of present space.* Before starting to design a new building, conduct a search. Can you find a needed space from the present building stock?;
- *Area planning.* How are the areas supporting sustainable lifestyles and well-being?;
- *Consider demolition.* Is it necessary? If you demolish, make a good plan for the demolition phase. Use as many demolished building elements and parts as a product as possible, and recycle the rest of the materials.;
- *Material development based on recycled materials.* Develop new materials using as many recycled materials as possible.;
- *Use secondary raw materials.* Use recycled materials and products in the new building as much as possible.;

## The planning and procuring phases – demand and design circular economy solutions

- *Design for a circular economy.* Design and develop buildings, products and materials in accordance with circular economy principles.;
- *Design "everlasting" buildings.* Make it your goal that the building designed by you will last forever.;
- *Procurements.* Demand is the strongest tool to promote the circular economy and sustainability. Use this tool!;
- *Minimize environmental impacts also in the use phase.* Take care of the buildings, maintain them, and efficiently use energy.;
- *Measure the change made.* Monitor and measure the change made. Make changes to the plans if necessary.;
- *Learning by doing.* It is not time to lose – the sustainability crisis is already here. We need to take action now, not only develop, design and conduct surveys. The step is not maybe perfect, but we can learn by doing.;
- *The role of data.* Collect important data during the life cycle of a building to help the evaluation of change. Use the data model as a data bank of materials and products.;
- *Responsibility via the life cycle.* Challenge the supply chain organizations to promote circular economy solutions.;

## Learn a lesson and collaborate

- *Smart solutions.* Use digitalization and smart solutions there where it gives added value. Remember, digitalization has an environmental footprint as well.;
- *New circular economy business models.* Adopt circular economy business models, such as product-as-a-service and sharing models.;
- *Collaborate.* There is a need for cross-sectoral collaboration. Share your know-how and do better business.;
- *The role of investors and owners.* The circular

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economy is a new business model – as an owner, a financier or a funder, it is your decision to demand more sustainable solutions.;

- *Be a proud professional.* The best act of sustainability is to build a high-quality environment that will last for future generations.

The next critical step is committing the industry to make the needed changes. There are still many challenges on the development path towards sustainability. At the same time, there is huge business potential in the circular economy. The most important task for the whole industry is to continue development work. It does not matter if you are the forerunner in the circular economy business or the second one. The only thing is, we all need to be part of this change. ■

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# Circular economy: The way to sustainable buildings

Expert article • 3343

**F**loods, fires, hurricanes, and intense waves of cold and heat are some of the climatic events that are increasingly frequent, and their extreme effects are already permanent in the world. The climate has already changed, and it is affecting every corner of the planet and the way we live. The need to reduce the negative environmental externalities associated with the linear model of production, based on the extraction and intensive consumption of natural resources, are already central guidelines of global climate and biodiversity policies. If, on the one hand, issues such as local scarcity and unbridled demand have intensified geopolitical issues, such as economic volatility and the increase in global commodity prices, on the other hand, overexploitation and degradation of ecosystems have caused irreversible environmental impacts, such as air pollution and water, changes in ecosystems, in addition to regional scarcity, even in materials considered abundant, such as sand and gravel.

The construction sector has effectively contributed to this scenario, being the largest consumer of mineral resources in the world, responsible for high levels of waste generation, greenhouse gases (GHG), and consuming more than a third of the total energy on the planet. In addition, population growth linked to urbanization, longevity, and rising incomes has increased pressure on governments to meet housing and infrastructure demands sustainably. The fact is that construction materials and products end up being wasted when they are no longer needed for their intended function, a fact that accelerates the devastation of ecosystems and brings risks of resource scarcity.

To change the current scenario, it is necessary to use resources more efficiently and minimize the generation of construction and demolition waste (CDW). Inefficient waste management, which ranges from non-existent collection systems to environmentally incorrect disposal, in addition to involving significant losses of materials that could be reused, causes damage to public cleaning services, compromises the functioning of drainage and urban mobility, generates visual pollution, soil, water, and air contamination and is a vector for the proliferation of insects and rodents, causing infections and transmitting diseases. The environmentally correct final disposal of waste in sanitary landfills also has issues that deserve evaluation, since the costs of implementing and operating these works are high. Minimizing waste is the first step that must be taken in waste management and the design phase is crucial to avoid waste, followed by strategies to recover materials and energy from waste. Reducing the burden of landfills could reduce global GHG emissions by 10 to 15% (UNEP, 2015).

In parallel, considering that 67% of global GHG emissions are related to materials management (CIRCLE ECONOMY, 2018), mitigating climate change requires implementing circular strategies and solutions to address the linear use of materials and energy. Decoupling the extraction and use of natural resources from current

production and consumption patterns can be one of the most economical and effective ways to reduce impacts on the environment and promote human well-being. Efficient use of resources can be achieved by different strategies, such as dematerialization; more durable products; more intense use; product upgrade, modularization, remanufacturing; and reuse of components. For this, the focus becomes the design stage, which should emphasize strategies that optimize the performance of the specified materials and promote the closure of material cycles, through maintenance, reuse, remanufacturing, renovation, and/or recycling.

The circularity of resources and construction products must cover all stages of the life cycle of buildings and the building must be designed and consumed as a dynamic, flexible object that evolves and adapts according to the needs of users. The focus is on building better. An efficient housing project, in addition to the efficient use of materials and minimizing the number of materials needed for construction, must prioritize the adaptability of spaces. Strategies such as modular construction, use of local materials, use of more efficient materials, use of secondary materials, and design for deconstruction should be an integral part of the projects. Furthermore, it is not just the quantity of inventory that matters, but more importantly, its quality, as better buildings and infrastructure will last longer, require less maintenance, and serve users' needs longer, resulting in an overall reduction in the load for the environment.

Adopting the circular economy is a prerequisite for more sustainable buildings. The construction sector needs to evolve towards a system based on circularity, in which buildings and construction materials are used, reused, adapted, and rebuilt, considering economic and environmental rationality at the heart of decisions. For all circular business models, information and communication technology is a key enabler. It is necessary to better understand what material is available, its quality, and when the materials become available for reuse, as well as their potential for reuse. To this end, material passports are key initiatives for documenting and tracking the circular potential of materials, products, and systems, providing guidance in choosing more sustainable materials for recovery and reuse. When scaling the circular economy, standardization of quality criteria and a common language is needed so that various initiatives can connect. Connecting systems such as digital marketplaces for Building Information Modelling (BIM), Life Cycle Assessment databases, and certifications are essential to achieve scale.

Implementation of circular practices in the construction industry is limited. The industry is conservative and has its design process, manufacturing techniques, supply chain, and financial arrangements. Furthermore, the fragmented value chain makes it difficult to share information and create industrial symbiosis. Understanding where value creation becomes circular should be the starting point for the organization or stakeholders. Policies around consumer taxation, legal frameworks, specific recycling targets, corporate accountability

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for products throughout the life cycle, implementation of tax premiums for the use of regenerated resources and building code regulation need to be reconsidered. There is a need for greater involvement of academia, industry, relevant stakeholders, and oversight bodies in participating in assessments to improve empirical processes and support the decision on the reuse potential of materials. This also includes understanding available indicators and technologies, from scarce resources to consumer behaviour, with a focus on closed-loop materials. ■

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ANDRÉ STEPHAN

# A circular construction sector: Mirage or reality?

Expert article • 3344

## Construction: a resource-intensive activity

The construction sector is responsible for most of raw material extraction, by mass. Raw materials are processed, manufactured into building products, transported to construction sites and assembled, to be locked into built stocks for decades, sometimes centuries. The processing of raw materials, their manufacturing, transport, construction, replacement and end-of-life, require significant amounts of energy and water, and result in a range of outflows, notably waste and greenhouse gas emissions. These embodied flows are very significant and can represent most environmental flows across the life cycle of a building, as research conducted by others and myself has shown.

In short, there is a critical need to rethink the entire life cycle of buildings and infrastructure, across design, use, maintenance, and decommissioning. This helps reduce resource use and environmental damage associated with construction. The circular economy (CE) is one approach in this direction and has been gaining traction.

## Circularity: new paradigm or back to the roots?

The CE has three main principles: 1) eliminating waste and pollution, 2) circulating products and materials, and 3) regenerating nature. When applied to construction, most CE initiatives tend to focus either on principle one or two. An example is the use of prefabricated bio-based construction assemblies with reduced waste, produced in factories using renewable energy. Prefabricated assemblies (e.g. partition walls) could be designed for disassembly, so that constituting elements can be re-used.

While the CE has had traction in recent years, it has been the paradigm that humans have used for most of their existence. Aborigines in Australia have established land-management techniques and societies that are in harmony with nature and which have been sustained for more than 40,000 years. CE principles are also present in extractive agrarian societies. The current citadel of Byblos in Lebanon was erected by crusaders by re-using centuries/millennia old stones on site, used by Romans, Persians, Egyptians and Phoenicians in other buildings. While the CE model is now being adapted to the Anthropocene, its basic principles have been around for millennia and much knowledge can be gathered by studying previous practices.

## Limits to circularity

Despite the promises of a more circular construction sector, there are limits that must be considered. Firstly, if economic models are based on blind growth, even if humans manage to circulate the entirety of materials in the Technosphere, there will always be an extractive demand for more. This is magnified by increasing demand, population, and affluence in many societies.

Secondly, a more circular construction sector depends heavily on “critical mass” – a large enough amount of materials that is

worthwhile harvesting and looping. With variability between buildings, lack of standardisation, and the disaggregated spatial and ownership nature of built assets, it becomes very expensive, labour-intensive, and technologically challenging to re-use existing materials. Large construction projects, such as hospitals or high-rise building, might present the critical mass for re-use, as done in ancient citadels.

Thirdly, the critical mass factor is compounded by the lack of pricing of embodied environmental flows of construction materials. It is sometimes cheaper to extract a virgin material far away, manufacture it overseas and ship it in, as compared to reusing locally. While other factors such as differences in wages and economies of scale come into play, the absence of an adequate price for embodied flows hinders deploying a circular construction sector.

Finally, the lack of knowledge and tools that enable deploying circularity in the construction sector is notable. Existing practitioners and even recent graduates are often ill-equipped in conceptual thinking and technical literacy, to deploy a circular construction sector.

## Towards a more circular construction sector

While full circularity is still a mirage, measures can already help decrease resource use in the construction sector. A short list includes:

1. Educating current and future generations of practitioners to design, operate, maintain and decommission (if necessary) built assets with a circular economy mindset, drawing on knowledge from the past
2. Improving the design of buildings, notably by building smaller and reusing existing buildings and/or materials and systems
3. Devising global mechanism to internalise the environmental and social costs of extraction and embodied flows into construction materials (e.g. a global ‘carbon’ tax)
4. Better understanding existing material stocks in buildings and infrastructure, using geographic information systems, expert knowledge, artificial intelligence, and other means.

These measures, combined with a move away from growth as the sole metric for economic prosperity, a more circular construction sector might slowly start moving from mirage to reality. ■



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# Mathematics of construction from Enlightenment to present

Expert article • 3345

One of the basic principles of sustainable construction is efficient use of raw materials. This is achieved by reducing the consumption of primary materials and by using renewable and recyclable materials. Obviously, structural engineers have a significant role in supporting the economical, environmental, and social pillars of sustainability when designing safe and healthy load-bearing structures, foundations and other components in buildings and infrastructure.

Like in many fields of engineering, the main tasks of structural engineering are design and analysis. Concerning design of load-bearing structures, the process consists of selection of shape, dimensions and specific materials followed by structural analysis under given loads. The structural analysis consists of finding the displacement, strain, and stress fields of the structure, as well as the support reactions. The process is then repeated until the structure satisfies the prescribed sustainability criteria. Computational design and analysis methods play a crucial role in this process.

Structural analysis is based on a carefully selected mathematical model which considers the geometry of structure, material properties, support conditions, and external loading scenarios. Such structural models are often formulated as boundary value problems of partial differential equations. These equations are derived from the laws of mechanics, and they express the balance of internal forces and moments of the structure. The equations are typically solved by a variational method like the finite element method (FEM), which transfers a static problem to a system of linear algebraic equations  $\mathbf{Ax} = \mathbf{b}$ , and a dynamic or a stability problem to a generalized eigenvalue problem  $\mathbf{Ax} = \lambda \mathbf{Mx}$ .

The term finite element method was introduced in 1960 by Ray W Clough at the University of California, Berkeley. However, the origins and developments of FEM have strong connections to the Baltic Sea Region. The foundations of the method are based on the work of Leonhard Euler on calculus of variations published in 1744. Euler is often considered as one of the greatest mathematicians in history. He held a position at the Russian Academy of Sciences in Saint Petersburg which was established in 1724 by Peter the Great to improve education in Russia.

Another significant contribution came from Boris Grigorievich Galerkin, who was a mathematician and engineer born in 1871 in Polotsk, Belarus and educated in Saint Petersburg Technological Institute. Galerkin was also a social activist, and he was even arrested and imprisoned after organizing a strike among engineers in 1905. After detention, Galerkin focused on science and engineering carrying on from the works of Euler in particular. He studied construction sites throughout Europe after which his academic work turned to an approximate method for partial differential equations, known today as the Galerkin method.

Following the earlier works of Ivan Bubnov, who was a marine engineer for the Russian Navy, Galerkin published his method in

Russian in 1915. The original formulation concerned the biharmonic differential operator arising in the analysis of plate and shell structures. The essence of the Galerkin method is formulation of the conditions of orthogonal projection that characterize the best approximation of the exact solution of a partial differential equation. The method was later extended to non-orthogonal projections by Georgy I Petrov and the most general version of the method is known today as the Petrov-Galerkin method.

The Galerkin projection is a very useful concept in the design of finite element methods and in their error control. The foundations of modern, functional-analytic approach to the numerical analysis of partial differential equations were laid down by the Czech-American mathematician Ivo Babuska in his seminal article "Error-Bounds for Finite Element Method" published in 1971. Babuska's influence to the finite element technology and its reliability has been tremendous and he was for instance awarded an honorary doctorate by the Helsinki University of Technology in 2000.

Modern digital technology combined with theoretical analysis can unleash the full potential of the Galerkin method. One internationally active research area is currently focused on the so-called discontinuous Petrov-Galerkin (DPG) method with optimal test functions. The DPG method appears to be very promising concerning applications in structural mechanics since the method can be used to predict efficiently and directly all relevant design variables needed for sustainable construction and reconstruction. ■



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# Use of drone technology in construction projects

Expert article • 3346

The general and wide adoption of drones in construction is like a major leap that has previously been compared to have the sort of influences on the economy of any nation like that of the mobile phones coming to replace the landlines. Drone technology, also known as unmanned aerial vehicles (UAVs), is an advanced technological improvement that must manifest in a growing economy as it is witnessed in developed sectors such as marketing, entertainment, and education among others. The fact that it provides digitization that carries immense importance in certain fields also makes it invaluable.

The acceptability of drones in construction sites is simply due to the many advantages which it provides as they provide a profound alternative to other manned data-collecting equipment. The traditional methods of carrying out construction work have been effective and desired goals are also equally arrived at but as pointed out companies must exploit the idea of incorporating new and improved approaches to expedite their project delivery and maintain their competitive edge in this booming and demanding market. Demand for effective building constructions like higher skyscrapers and grander institutional buildings are on the increase. In summary of the above-reviewed publications, the following are arrived at as;

## Topographic mapping and land surveys

Drones can be actively deployed to cover such tasks and the fact that drones can cover a wider area of land quicker makes room for the elimination of errors and the projects are also executed as scheduled on a reasonably appropriate budget.

Another major benefit of using drones is that it provides decision-makers with higher-resolution imagery, which can be effectively converted into 3D images.

## Equipment tracking and automating

The fact that there are usually numerous pieces of equipment at any construction site which is bound to be a wide area of land is enough to cause a serious headache for project managers. When a drone is employed, the said project manager can access the areas, nukes, and crannies of a project site and easily locate a particular equipment and he can also discharge any which is not needed any longer on the site to avoid incurring unnecessary expensive accidental extension charges.

In the future, drones will be able to direct and guide autonomous vehicles, which is sure to revolutionize the industry on a new scale.

## Remote monitoring and progress reports

In cases whereby clients are not able to present themselves physically on the field for the inspection of their investment, the coverage and recordings which are made with the use of drones can assist project managers or contractors when presenting the state and extent of any particular project to its investors. Also, as a way of correlating data

and ensuring a uniform level of information is present with all the team members of a project, data obtained from UAVs can be promptly circulated between the interested parties including engineers, construction managers, workers, and owners.

## Security surveillance

A drone operator can conduct a flyover and quickly see if a piece of equipment is in a secure enough location. The surveillance camera could also be utilized to see if there are unauthorized individuals on the site. This will prevent damage or theft long before it occurs.

## Safety

The safety of lives should be the primary concern of all and sundry in any given construction site. It has previously been recorded that about 39% of the accidents that occur are falling. Some little tasks which include taking measurements will usually involve labor climbing over dangerous heights. Drones can effectively replace workers in these situations and mitigate the risk construction workers face in the field.

## Promotional photography

The importance of social media as an important marketing tool in businesses nowadays cannot be overemphasized. Social media platforms provide an avenue for entrepreneurs to market and showcase their products to the world and as a result, attract prospective customers. Architectural buildings which are well presented with good photographic images from phantom positions will allow owners/sellers to air out what they have for their intending patronizes. The drones offer the opportunity to capture the real scale and size of a project in minutes.

## Transportation of goods

The small sizes of drones have previously played against their use in the transportation of goods and other materials relatively lightweight. At this present time, drones are used to pick up and transport materials across project sites away from the traffic conditions moving landed like the car, motorcycles or bicycles might encounter. ■



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# Recycling is a key to the sustainable marine ecology and economy

Expert article • 3347

Throughout the ages, man has been thinking of the seas to be so great, that his actions does not affect them. All pollution that enters the sea, be it toxins, sewage, nutrients or plastic waste, is thought to dissolve and mysteriously disappear into the oceans and to their an almost infinite amount of water without being able to affect marine life.

Now, this fundamentally the same line of thought is in our approach to cleaning up polluted seas. All too easily, we think the seas are too big to clean, and we push the whole thing into the background of our thinking.

However, when we stop to think, every responsible person understands that both ideas are absolutely wrong. The seas are not too large to be damaged by human activities. Nor are they so large that we could once cleanse the damaged sea and restore its original vitality. The question is how strong our common will is on this issue.

Now, at the latest, it is time to embark on determined measures to improve the state of the seas, both through global joint efforts and through regional efforts that go as far as one individual. Each of us can do something to ensure the viability of the seas for future generations as well.

Climate change is the biggest threat to marine health. This does not mean that, under its guise, we can abandon local measures to reduce the burden on the various sea areas. Healing the seas requires both mitigating climate change and reducing local nutrient emissions, toxic emissions and littering, especially plastic littering.

The importance of climate change for marine health comes through a number of different mechanisms. The sea is the largest single carbon sink. The seas sequester more than a third of the excess carbon dioxide in the atmosphere. This has had a clear impact on the state of both the seas and their organisms. Increased dissolution of carbon dioxide acidifies the sea. This, in turn, has major implications for marine animal and plant health. Perhaps most clearly this is evident in the dying corals. The shell of corals is mainly calcium carbonate, the solubility of which is strongly dependent on pH.

In the case of the Baltic Sea, the effects of climate change are increasing rainfall in the catchment area. This will further dilute the low salinity, which in turn will have a major impact on the current viability of fish in the Baltic Sea, as well as other species.

In the Baltic Sea region, both public and cross-border actions by private organizations have been quite effective in reducing the burden on the sea. However, it is good to remember that Europe's largest desert is at the bottom of the Baltic Sea. Once dead, the seabed takes a long time to recover. If recovering at all.

There are areas in every sea that are more sensitive to external stress, such as nutrient loads, than others are. In the Baltic Sea, such an area is, for example, the Archipelago Sea between Finland and Sweden. The archipelago sea is very shallow on the Finnish side. The average depth is only 23 meters. Thousands of small islands affect water flows and nutrient loads brought by rivers in the catchment area

dissolve in a relatively small amount of water. This had caused the eutrophication of the Archipelago Sea, although stricter agricultural regulations have reduced the amount of nutrients used already for a couple of decades. Over the last hundred years, more than 40 million tons of mineral phosphate have been imported from outside to the Baltic Sea catchment area. We know now that it takes decades to drain from the fields into the sea.

With the eutrophication of the sea, both natural values and business opportunities are lost.

The widespread application of the principles of the circular economy in the marine environment would be the key to improving marine health\*. It would also provide much greater opportunities for the use of the goods provided by the seas. For the most part, for example, the technology for making recycled fertilizers already exists. It is an utmost importance that we apply immediately all possible means to reduce nutrient flow into Archipelago Sea and develop rapidly new technology to remove excess of nutrients both from the catchment area and directly from the sea. Removal of nutrients, especially phosphorus and nitrogen, in large scale from the ecosystem formed by the catchment area of Archipelago Sea and the sea itself is urgently needed to save this unique ecological entity with tens of thousands of small islands and characteristic fauna and flora.

*\*This has been discussed in details in our recent book entitled "Saaristomeren Sininen kirja" in Finnish and "Skärgårdshavets Blåa Bok" in Swedish (ISBN 978-952-69442-3-4 (PDF)).*

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# BALTIC RIM ECONOMIES

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