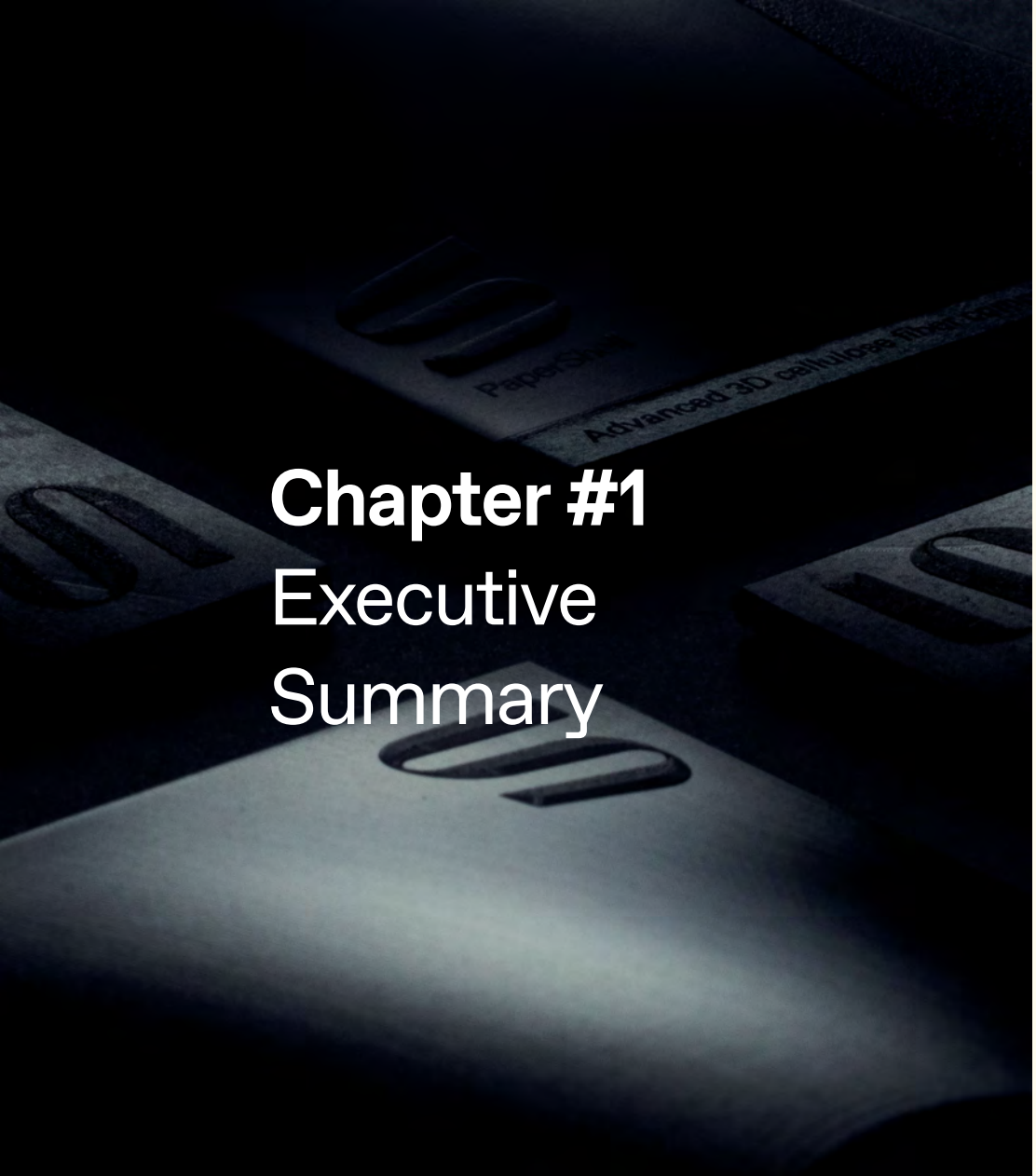

PaperShell



Chapter #1
Executive Summary

"In our highly automated factories, we re-engineer kraft paper back into a wood.

Resulting in a high-tech, 100% fossil carbon-free structural 'origami'. Exceeds the strength of plastics, matches the versatility of glass fiber, surpass the lightness of aluminum, and outperforms traditional wood in durability.

Empowering designers, architects and companies to switch to biogenic materials in existing components or creating sustainable new products, drastically cutting greenhouse gas emissions, and fortifying their brand presence on the path to a circular bio economy."

PaperShell - where science meets art and finance supports nature

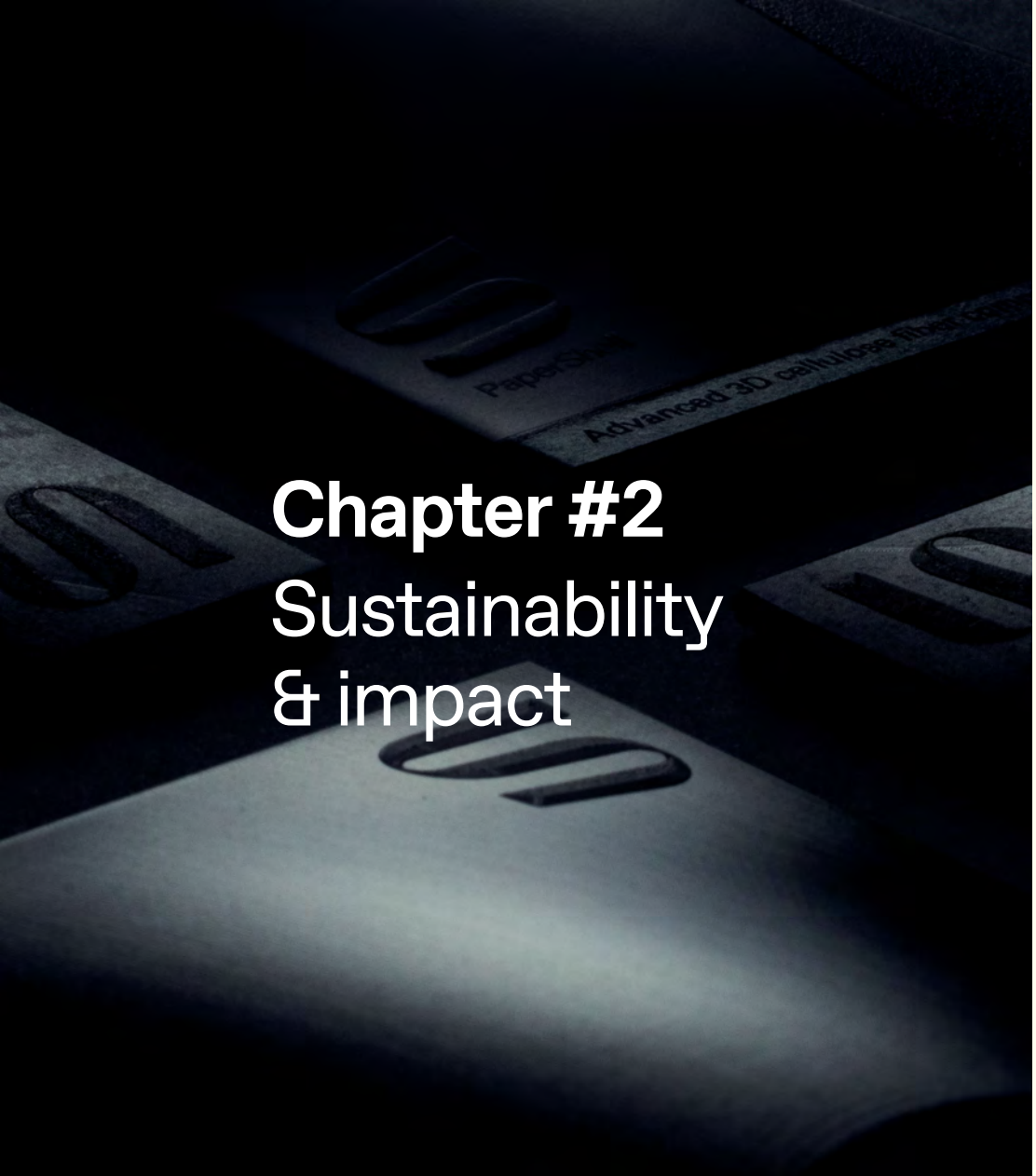
An increasing number of companies are setting ambitious targets on emissions from the entire value chain - resulting in increasing demand for low-carbon materials. Setting hard requirements on sustainability performance expected to increase on their suppliers. Supplying low-carbon materials will be an competitive advantage in most industries.

PaperShell has the core belief that solutions to the climate crisis and a sustainable management of resources is found in nature. We reverse engineer paper back into high tech 3D-wood components: Stronger than plastics, versatile like glass fibre and lighter than aluminium. Enabling companies to switch materials in new or exciting products. Helping them substantially decrease CO_2 impact as well as enabling them to transition towards a circular bio economy. We're taking a pioneering role in the transformation towards a local and circular biobased society. Hindering large amounts of GHG emissions entering the atmosphere aiming for carbon net zero (COP21), regeneration (COP15) and beyond.

PaperShell AB was founded in 2021. The first component tests were carried in 2018 but the original idea behind PaperShell was based on the urgent needs for middle management to find and secure feasible, stable and large enough volumes of sustainable and preferably bio-based material solutions.

We're a diverse and purpose-driven team cross breeding design, science and industrial technology. Inspired by nature's 3.8 billion years of bio intelligence. In our highly automated production lines we produce our clients print-to-build B2B components that replace bulk materials like wood veneer, plastics, fibre composites and metals such as press moulded aluminium parts.

PaperShell is collaborating with some of the world's best-known brands to switch their components in their products to PaperShell's material solutions. From our highly automated green factories in Tibro, and with our showroom in Stockholm, we support partners all over the globe in their transition from fossil-based or environmentally hazardous material solutions to 100% biogenic composites. Our team includes scientists, engineers, designers and professionals with long term expertise from the target markets. Guiding our clients from earliest feasibility studies, prototyping and testing to automated mass production, providing metrics and brand opportunities within the forefront of sustainability. Our board and investors have strong and in many cases famous industrial, entrepreneurial, engineering or design backgrounds. The team is committed to industrialise, scaling and creating value for our customers and investors helping them reach our mutual and urgently need sustainability targets.



Chapter #2
Sustainability & impact

“By closing the loop, working with nature and towards a full circular bio economy, returning biological nutrients and atmospheric carbon back into the soil - achieving net zero, creating carbon sinks, and implementing regenerative and bio up-cycling solutions is achievable long before 2030"

Tailwinds for sustainable materials are found in the regulatory environment across the globe, with the strongest push in Europe

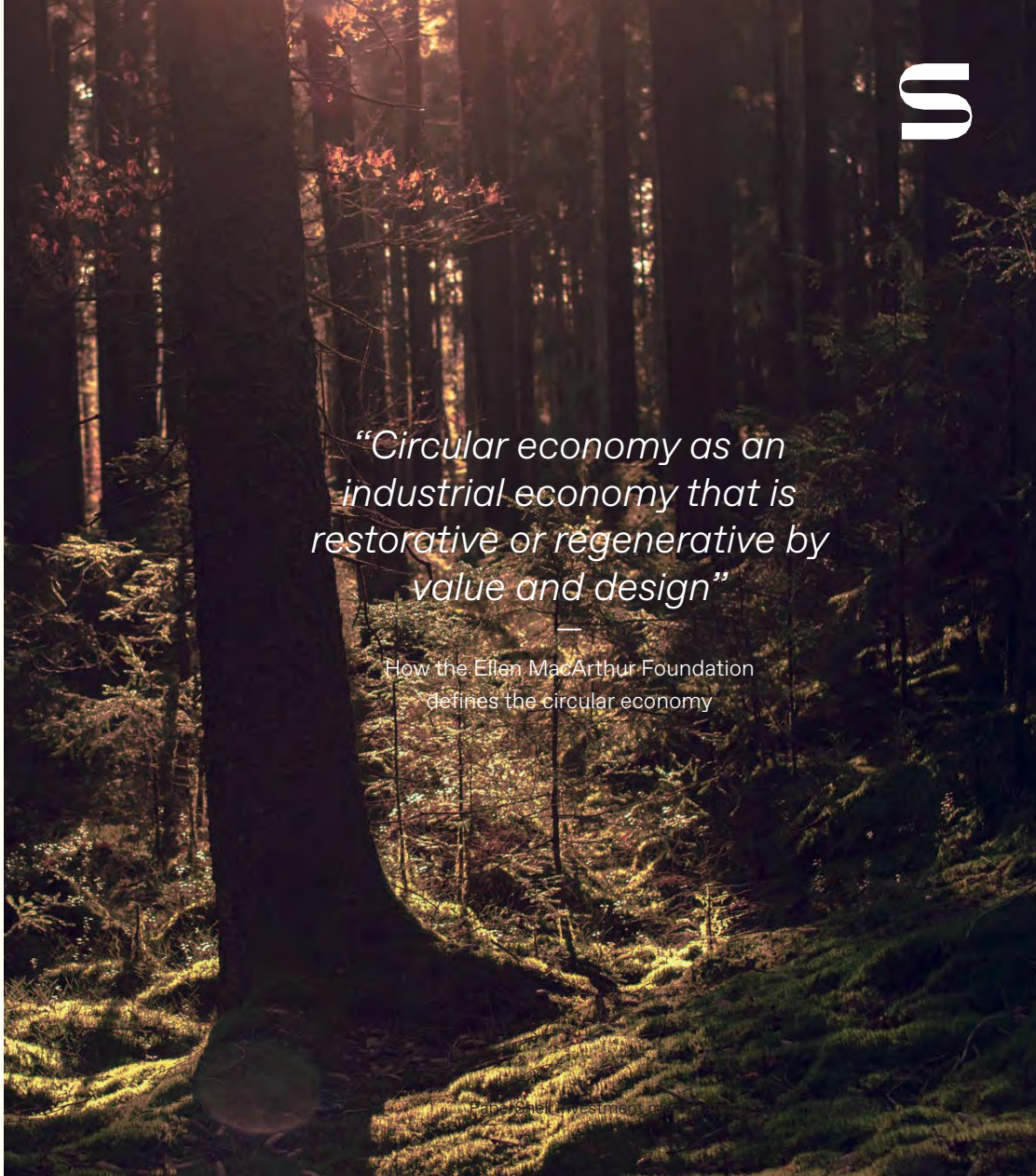
We humans have a daunting task to resolve the challenges of transforming our societies, industries and basically our way of life towards sustainability and according to nature and avoiding crossing the so called planetary boundaries. In order to avoid this fate, companies have committed to achieving their sustainability goals outlined in the UN's Agenda 2030 and the Paris Accord (COP 21). Global warming and biodiversity loss is driving legislation and investment toward green technologies, as evidenced by the recent COP15 summit. Companies have few years left until 2030 to reduce green house gases emissions substantially.

Most greenhouse gas emissions come from material extraction, resource management and design choices. This is where 80% of their environmental impact is determined. The corporate world is therefore hunting for more locally sourced, sustainable bio materials to replace environmentally problematic materials such as plastics, glass fibres and metals. Companies wish for stable and large enough volumes of sustainable resources that can be secured over time in a financially volatile and geopolitically problematic global market. Why resource management and sustainability now go hand in hand with any strategic agenda and viewed as risk management within corporate strategies and governance.

However, the demand for sustainable materials such as bioplastics, recycled plastics, and natural fibre composites far exceeds the supply. In the case of bioplastics, the environmental impact is in question as they often compete with farmland needed for food production. The yield is low, and the logistical chains are long. Recycled materials on the other hand, are struggling with traceability, contamination from foreign materials such as flame retardants, softeners, and other additives. Furthermore, only a small portion of plastics and hardly any of the fibre composites are recycled back into the loop within the EU. There is a clear increase in mixed materials with combinations between for example plastics and environmentally friendly materials, but they seldom reduce the amount of fossil-based content with more than 50%, and recycling becomes problematic or impossible when one material group is blended with another. This demand-supply gap makes it hard for middle management to fulfill sustainability commitments made by top management within large corporations.

The green gold

The forest industry and agro-waste streams are the only two viable resources large enough to support the resource demand of bio-based material solutions. To achieve a bio-based circular economy using these two valuable resources, must be treated with uppermost care and understanding as "doing less a bad is not to doing good". Instead of making single use items such as paper straws or packaging material or worst turning forests into biofuel is leading to deforestation and is raising strong concerns from the sustainability societies.



There is a need for a sustainable materials revolution – PaperShell is part of the solution

THE GLOBAL GOALS

Sustainability and circular economy is high on the strategic agenda. Global warming, geopolitics and financial turbulence is driving legislation and investments towards sourced green tech.

The demand for bio based materials are high. So called sustainable material on the market are often far from fully bio based. PaperShell is 100% biogenic storing atmospheric CO2

Every kilo of material such as plastics, glass fibre and metals replaced by PaperShell, will drastically hinder CO_2e emissions released into the atmosphere.

In the traditional linear economy take, make, waste is the norm. PaperShell can be recycled as wood or better returned back into nature achieving > net zero carbon (COP21) and bio up-cycling (COP15)

Few bio based materials can support the huge volumes needed. PaperShell is based on ingredients that can be locally sourced with stable and large scale availability.

The need for strong materials is growing fast in the transition towards an electric society. PaperShell has a competitive strength to density ratio with properties resembling that of fibre composites

The science based targets initiative (SBTI) drives ambitious corporate climate action by enabling businesses and financial institutions globally to set science-based greenhouse gas (GHG) emissions reduction targets.

- In 2022, 1,097 companies had science-based targets validated, surpassing the total for the previous seven years combined.
- Japan led in setting targets, followed by the UK and the US, with Asia experiencing the most growth.
- Small and medium-sized enterprises (SMEs) made up the majority (58%) of organisations with targets in 2022.
- Targets aligned with 1.5°C were accepted by the SBTi as of July 2022.
- Companies with science-based targets or commitments represented 34% of the global economy by market capitalization in 2022.
- France's CAC Index had 88% of companies with targets by the end of 2022, compared to other indices like Germany's DAX (70%) and the UK's FTSE (69%).
- §60% of companies with targets came from service, manufacturing, and infrastructure industries, with the materials industry seeing the most growth.

These statistics highlight the significant increase in science-based targets among various industries and regions in 2022.

Towards a circular bio economy

PaperShell aims to lead and for our clients enable the transition towards a Circular Bio Economy, aligning with global sustainability frameworks (Sustainable Development Goals (SDGs), COP15, COP21, Planetary Boundaries etc) aiming for carbon net-zero objectives and beyond.

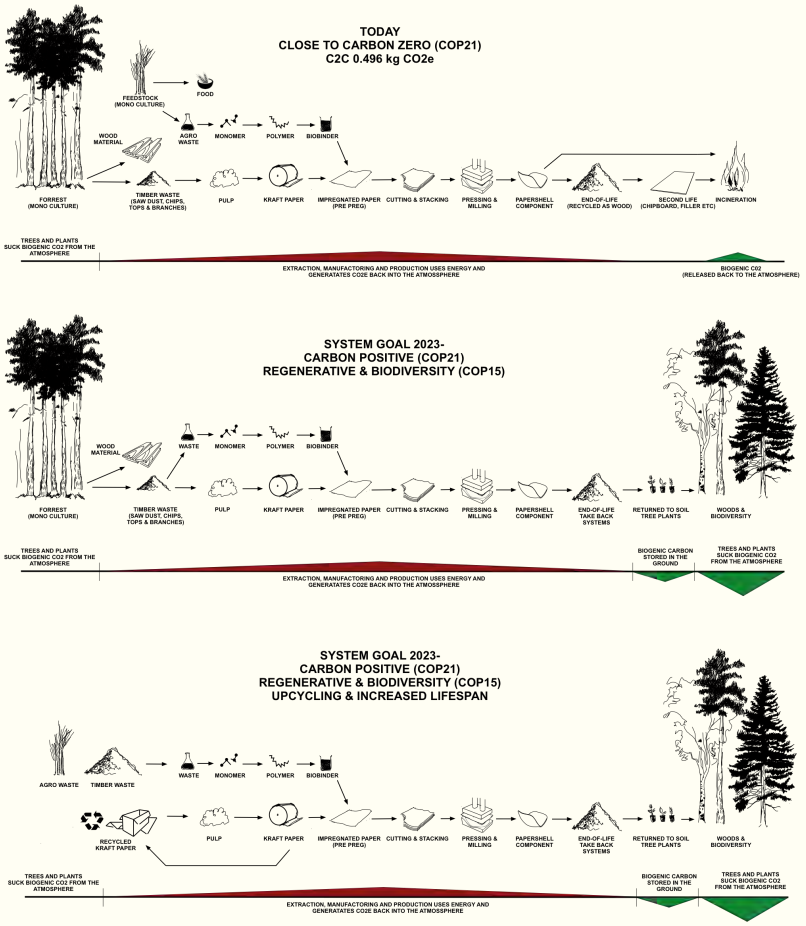
At PaperShell, we are dedicated to building paper back into an artificial and high tech wood creating strong load bearing components. An advanced version of structural origami that store bio-carbon instead of wasting trees and plants on single-use items or biofuels. We're taking a pioneering role in the transformation towards a local and circular biobased society. Our innovations and processes produce long lasting, technically advanced and aesthetically pleasing high value components. Enabling our clients to replace their materials in existing or new products. Helping them achieve targets and metrics, so they can communicate and brand, commitment and tangible traction on sustainability and transition towards a circular bio economy.

Our materials are 100% fossil free, storing 1,51 kg of biogenetic ie “atmospheric” carbon per kg ready made component. The material is sorted as wood end of life (EoL) at any recycling station globally. As PaperShell production is highly automated and energy efficient the Green House Gas (GHG) emissions or “C02 costs” to produce one kg ready made component is exceptionally low. Latest LCA, Cradle to Cradle (C2C), including single life and incineration EoL, show a negative impact of 0.469 kg CO_2e per kg PaperShell component which is 25% of the negative impact of an average Swedish lunch. 90-98% less negative impact than the same components made of plastics, fibre composites or metals. Meaning that each kg of component made of PaperShell, leaving the PaperShell factories, so called Cradle to Gate (C2G), is one kg carbon negative. (1.510 - 0,496 =1,01 kg biogenic CO_2e.)

But green house gases are just one dimension of planetary boundaries why aspects such as land and water use, resource depletion etc are equally important. At present a component of PaperShell’s total weighted single score per functional unit (EF3.0) vastly outperforms any other material in comparison made by third party, even components made of wood veneer.

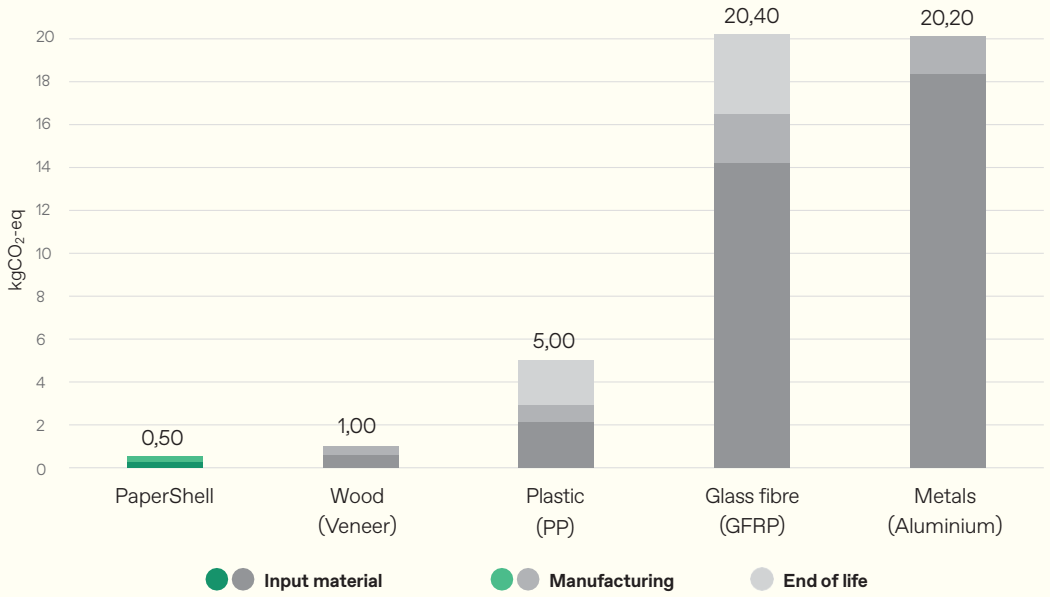
We also offer and support our clients circular bio economy solutions: by closing the loop we can utilise technologies such pyrolysis (bio char) or even mycelium to convert PaperShell components EoL into soil, focusing on its effective utilisation for biodiversity promotion and carbon capture (sequestration). Establishing sustainable business models and bio up cycling potentials such as reforestation, agroforestry, financial aspects such as carbon credits and the like. Creating soil that stores up to 1 kg of biogenetic carbon per kg returned component of PaperShell in the ground is where the true circular bio economy lays.

We want to act as a catalyst and set new global standards for ecological and interconnected industrial practices. We aspire to align our economic-industrial model with established circular economy principles such as those advocated by the Ellen MacArthur Foundation and the Doughnut Economy and most importantly pay respect and find inspiration in nature’s 3.8 billion years of bio intelligence.

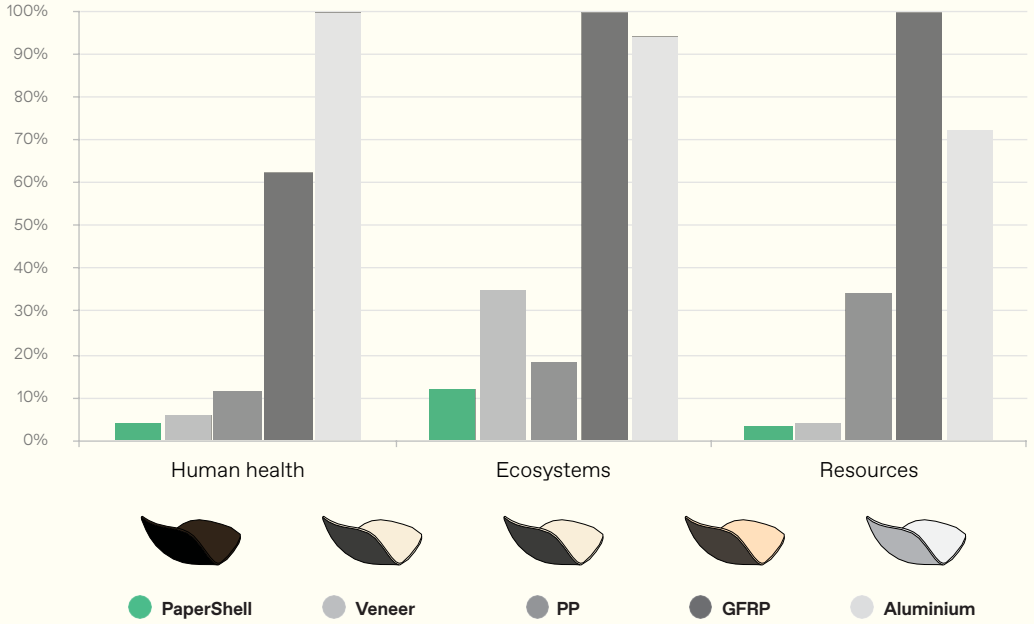


Climate impacts per functional unit as of today (trimming constantly)

Life Cycle Analysis* (Cradle to cradle, C2C, based on incineration end of life. I.e. biogenic carbon released back into atmosphere.)



Endpoint impacts per functional unit (ReCiPe)



Sources: LCA calculations made by third party environmental consultants using SimaPro. Full LCA report accessible for download on www.papershell.se.

Material transition impact

Wood (veneer) refers to thin slices of wood usually thinner than 3 mm that typically are glued together or mounted onto panels to produce flat or single curved panels for furniture, doors, flooring, etc. Apart from fossil based glues pressed moulded veneer components are free of fossil based carbons.

Wood (veneer)

2 x more CO_2 emissions

PaperShell gives higher design freedom (geometry, surface detail, etc.) and are much more moist resistant, flame retardant and outdoor resilient.

Plastics (PP) is one of the most common and classic thermoplastics that can be reheated and recycled again without significant degradation. Unfortunately, many plastics are contaminated with additives and flame retardants, lost and/or burnt, and only about 42% of all plastics in the EU are recycled. PP is recycled to a much lesser extent. Plastics like PP are 100% fossil based and will release its fossil carbon in the atmosphere end of life.

Plastics (PP)

10 x more CO_2 emissions

With PaperShell you are moving away from a fossil based resource. If incinerated it will only release atmospheric carbon. If brought back into nature PaperShell will store atmospheric carbon in the ground and add to soil enhancement and bio upcycling

Glass Fibre (GFRP) is a versatile material due to its lightweight, inherent strength and weather resistance. Manufacturing of fibres uses large furnaces to melt silica sand, limestone, kaolin clay, fluorspar, colemanite, dolomite, and other minerals and is very energy intensive. The binders needed such as epoxy or PET resins are fossil based and hazardous flame retardants are frequently added. Recycling solutions for glass fibre composites are rare or non-existent in most regions.

Glass fibre (GFRP)

40 x more CO_2 emissions

With PaperShell you have much less negative impact you have a renewable and controlled resource from EU and your product will be sorted as wood EoL or can be returned to nature.

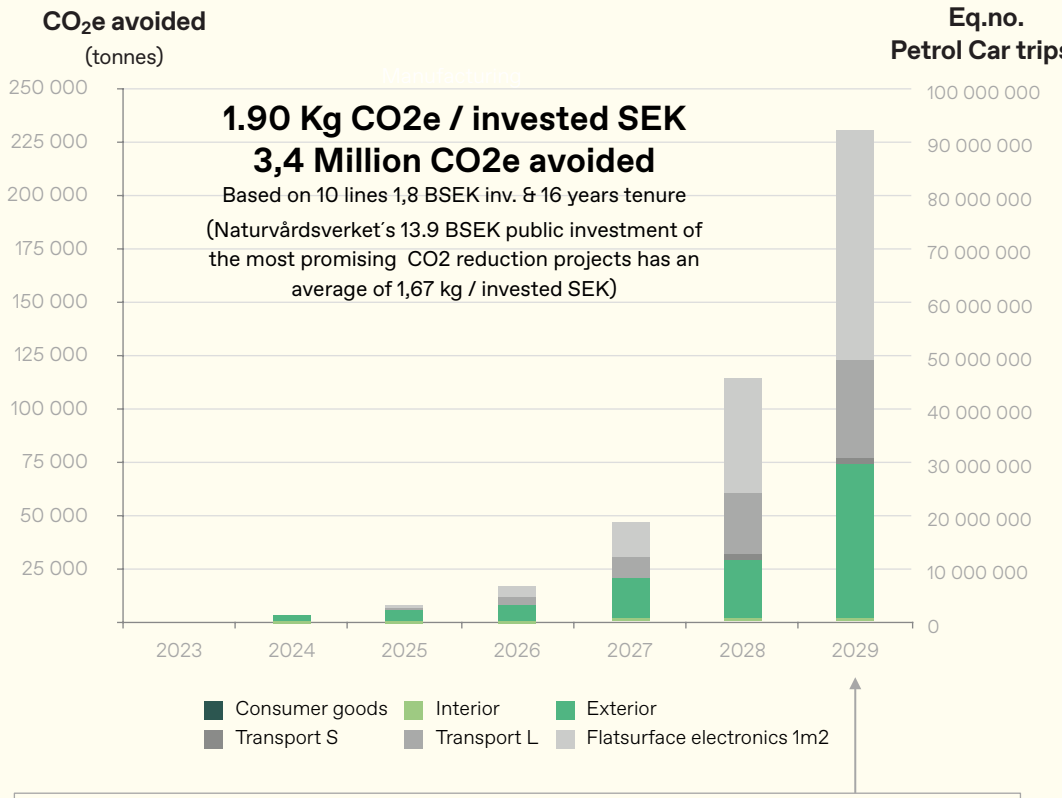
Metal (Aluminium) is a strong and lightweight metal which is good for recycling. However, it requires a lot of energy to extract from Bauxite ore. To produce pure aluminium, 3 – 4 times more energy is required compared to producing iron. Huge amounts of both fossil fuel and electricity are used. The extraction is mostly in Australia, China, and South America. However, it takes 20 times less energy to recycle than to produce so keep this material in the loop!

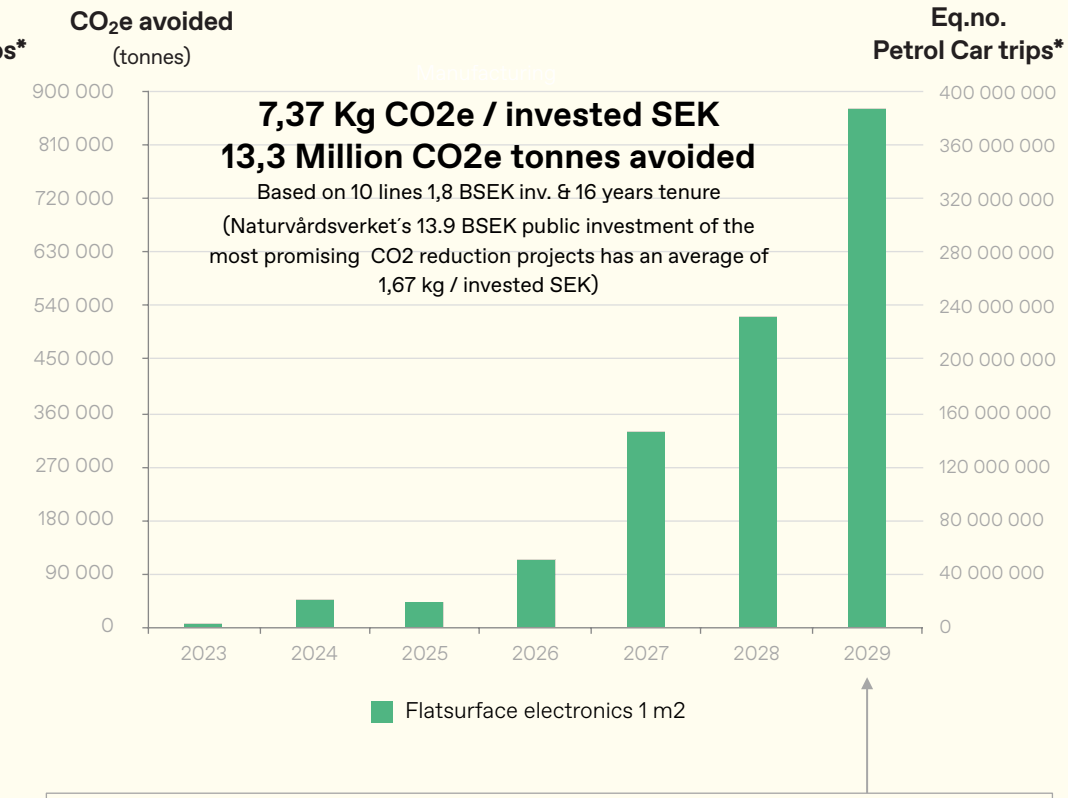
Metal (aluminium)

40 x more CO_2 emissions

With PaperShell you have much less negative impact you have a renewable and controlled resource from EU and your product will be sorted as wood EoL or can be returned to nature.

Avoiding GHG emissions through PaperShell scaling





With the proposed product mix, we plan to cut CO_2 emissions by 230,000 tons in 2029. To illustrate, this is equivalent to offsetting 96 million 15-km car trips.

Replacing just fibre glass alone would slash emissions by a remarkable 872,000 tons, offsetting a staggering 363 million 15-km car trips.

* Assumptions: An average car emits 2.3 kg of CO_2 per litre of petrol. A 15 km car trip uses about 1.05 litres of petrol, emitting approximately 2.4 kg of CO2 per trip.

Achieving carbon net zero and beyond through value chain collaboration and circular bio economy EoL

Manufacturing PaperShell

+0,5 kg CO_2

The manufacturing GHG "cost" of 1 kg of a component (LCA C2C) in PaperShell is equivalent to 25% of negative impact of an average Swedish lunch.

Atmospheric (biogenic) carbon dioxide stored in PaperShell

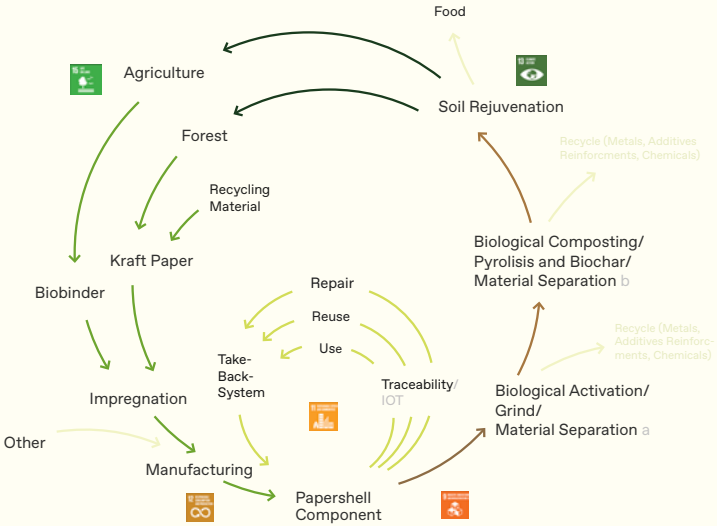
-1,51 kg CO_2

PaperShell is 100% fossil free and 1 kg stores equivalent to -1,51 kg biogenic CO_2e/kg. Meaning that if components of PaperShell is brought back into nature in a way that the carbon is stored, then we would reach carbon net zero and beyond.

Cradle to Gate (C2G): 0,50-1,51=

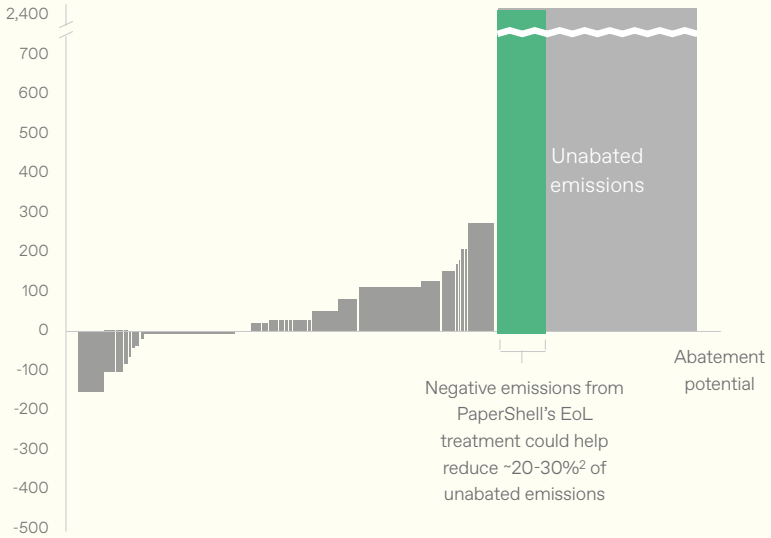
-1,01 kg CO_2e/kg (atmospheric)

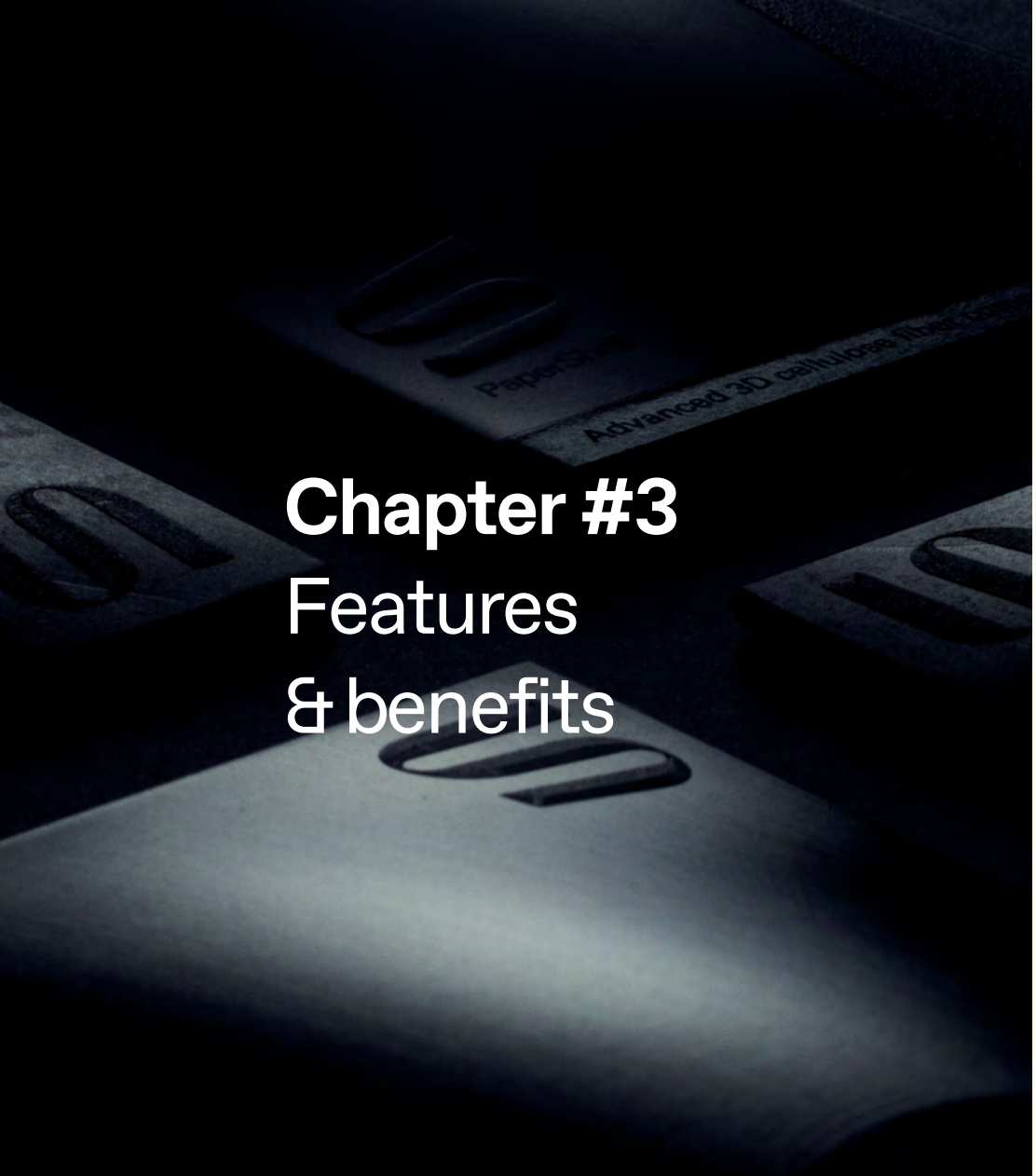
By closing the loop we can utilise technologies such pyrolysis (bio char) or mycelium to convert PaperShell components EoL into soil, focusing on its effective utilisation for biodiversity promotion and carbon capture (sequestration). Establishing sustainable business models and bio up cycling potentials such as reforestation, agroforestry, financial aspects such as carbon credits and the like. Creating soil that stores up to 1 kg of biogenetic carbon per kg returned component of PaperShell in the ground is where the true circular bio economy lays.



Exemplary MACC for household appliances, 2030

Abatement cost, USD/tCO2e





Chapter #3
Features & benefits

"We are not only more sustainable than traditional wood veneer but also dedicated to replacing and reducing the use of aluminium, plastics, fiber composites (including glass and carbon), and, in some cases, even steel. Our solution is a load-bearing cellulose fibre composite, 100% fossil free biogenic structural and beautiful origami."

Features and benefits

Materials
Load bearing cellulose fibre composite that can replace wood veneer, plastic, fibre composites and in some cases, metal.

Design freedom
Double curvature potential, to replace expensive 3D veneer alternative and plastic replacement.

Strength and material efficiency
Strong and load bearing composite. Due to its specific strength PaperShell can replace components with less material making it material efficient.

Moist resistant
Hydrophobic, allowing for wet spaces and outdoor environments. Unique for natural fibre composites.

Fire properties
PaperShell's fire properties is a great asset in commercial transport areas such as trains, planes, boats and buses.

Look
Unique exclusive look and class A surface possibilities reducing need for surface treatment.

Sustainability
Renewable natural resource. Upcycled and Recyclable as well as Biodegradable.
A material tailored for a bio-based circular economy.

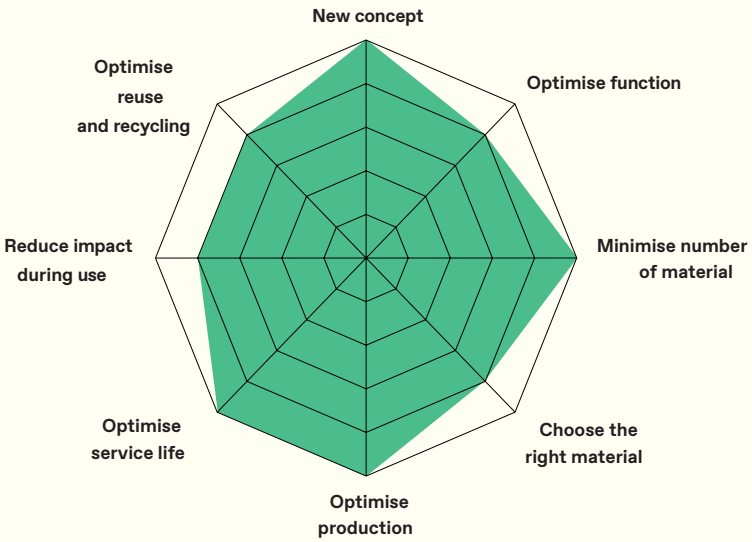
Automatisation
Due to innovative material features, automation and flexible production is possible for large scale up.

Availability
Large scale input material availability. High capacity ramp-up (> million components 2027).

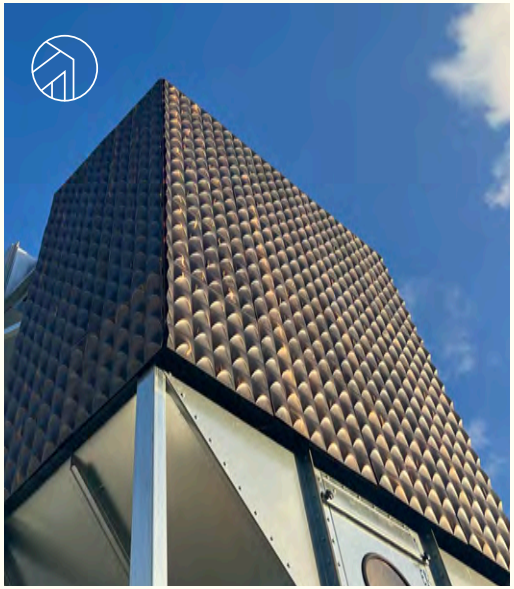
End-of-Life
Sorted as wood in recycling fraction globally. Closed loop enables carbon capture and bioupcycling.

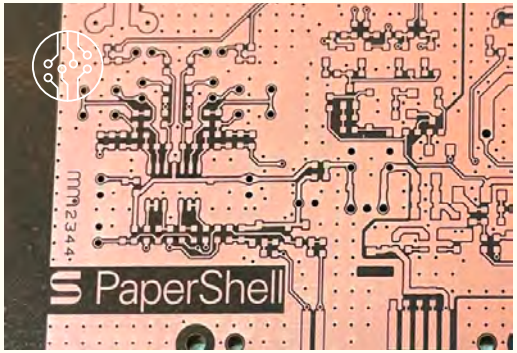
Eco Design Wheel

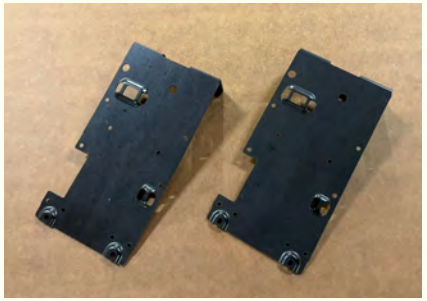
Eco Design Wheel, also known as Eco Design Approach or Eco Design Strategy, is a process that aims to create environmentally-friendly products and systems by taking into account the entire lifecycle of a product, from its design to its disposal.

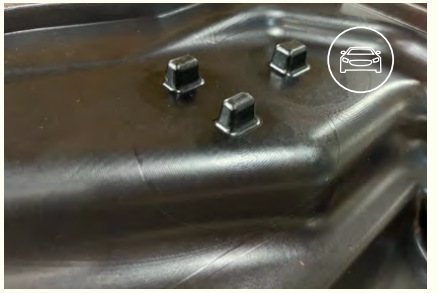


Structural origami // Artificial High Tech 3D-wood







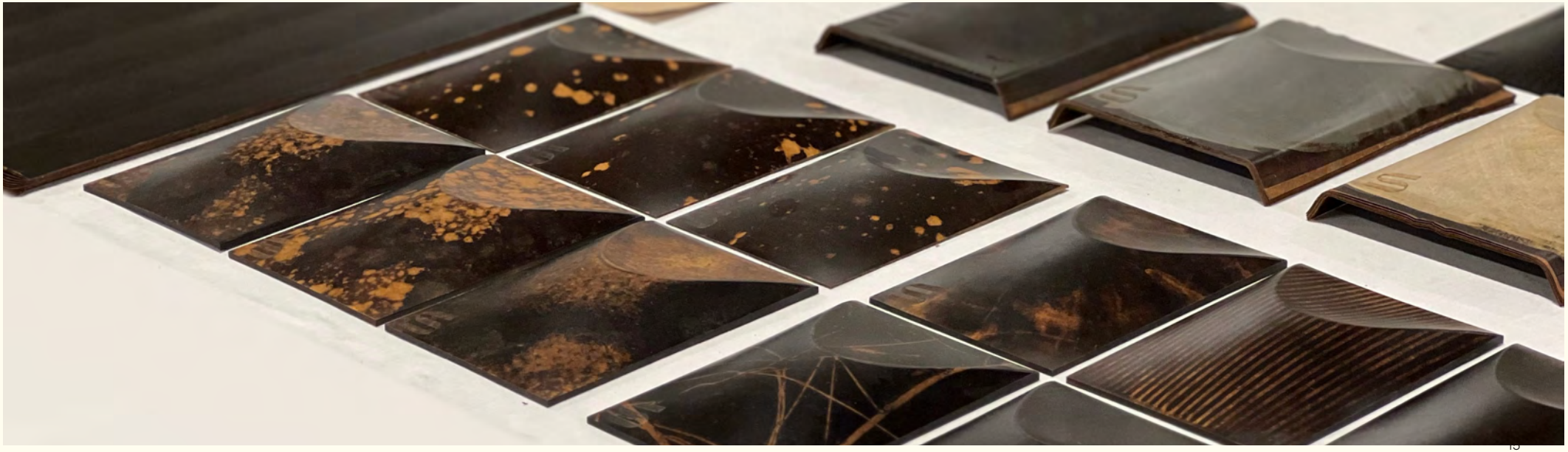


Aesthetic sustainability - Natural and exclusive look

It’s not just about materials; it’s about creating value that resonates. We collaborate with our clients to explore and enhance tactility, haptics, patterns, grains, graphics and all types of finishes, ensuring that our solutions maximise value for our clients.

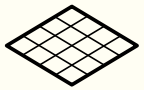
Our composites have a unique look and feel. It can be used for visual class A surfaces, portraying a sensation and narrative of something new, technical and ecological at the same time.

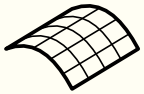
Our clients often ask about colours but when understanding the materials unique identity decides to expose its sincerity just like it one would with high value woods, leathers or other natural materials. At the same time they appreciate the level of detail and technical look that can be achieved, which is very uncommon for natural materials. Indoors it keeps it’s natural and exclusive look. Outdoors, untreated, it turns silver grey just like wood does but without losing performance that natural materials such as woods does.



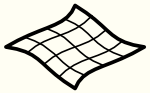
PaperShell offer a wide range of possibilities

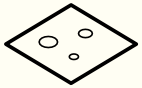
Shapes


Flat

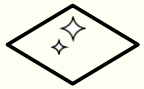

Single curved

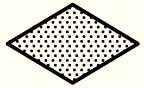

Double curved / sphere

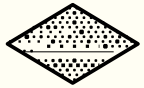

Complex


With holes

In mould surfaces


Gloss - satin finish

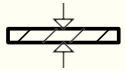

Matte finish

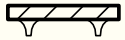

Rough surface


Pattern


Pictures / Text

Material


Thicknesses
Thickness span 0,5 to 10 mm.


Fixation possibilities
Ribs and bosses


Local reinforcements
Ribs, various thickness or local reinforcements (with bio based materials)

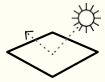
Production process

Fully automated compression moulding process

Technical Data Sheet

PaperShell properties

Heat resistance
STD 104-0001 / ISO 3795



UV Resistance
STD 423-0061

Scratch Resistance
STD 423-0030

Heat Aging
2000h Volvo STD 423-0055, 15% decrease

Climate Cycling
0,22% moisture absorpt. 400h - 6h 85°C, 21h 38°C 95% RH, 5h-30°C

Moisture Aging
6% moisture absorption 1008h - 38°C 95% RH

No VOX
Volvo - STD 429 - 0003

Impact Resistance
EN 13087, Room Temp, 11 J, -22°C, 11 J

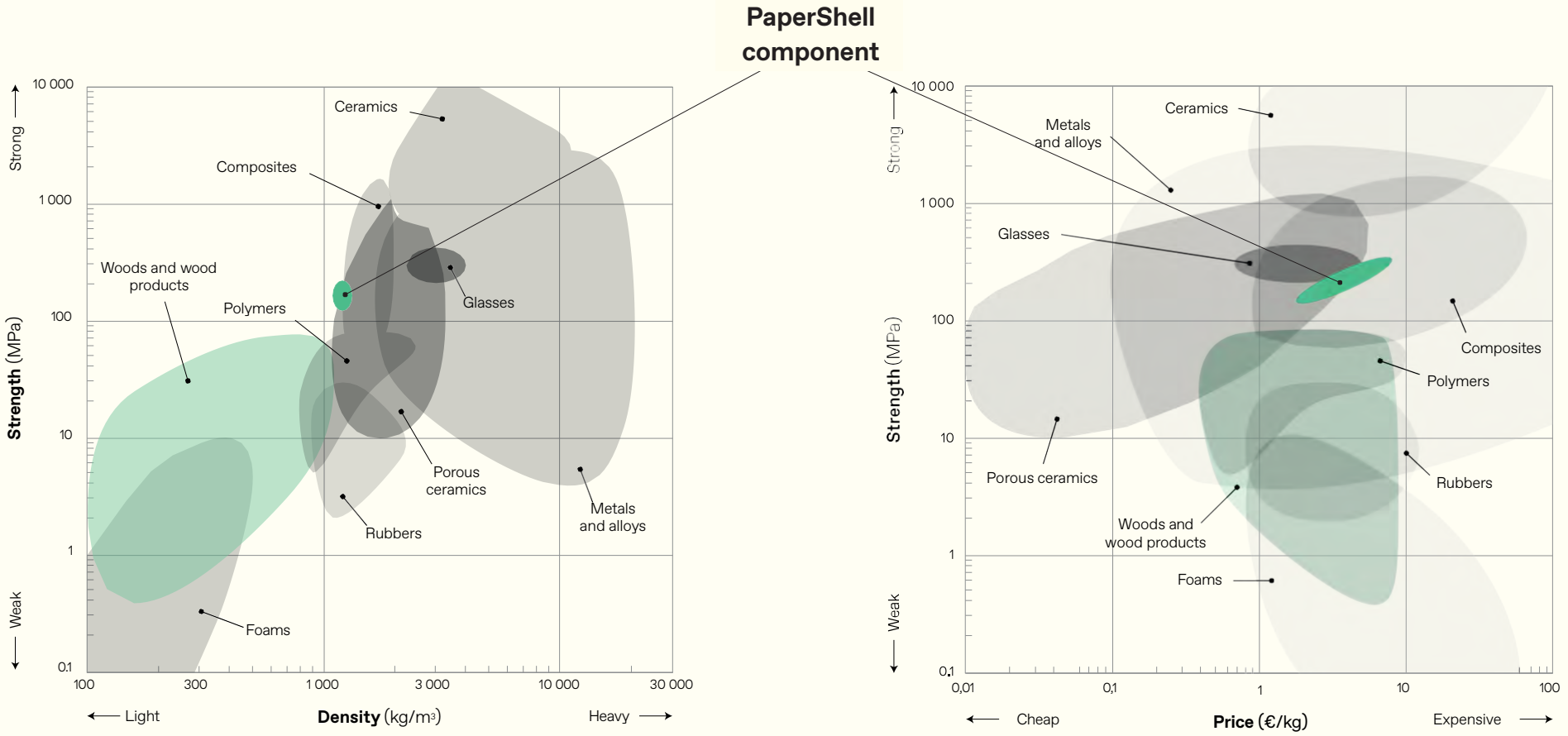
Physical properties

Density	1,34	g/cm3	ISO 1183
Tg	145	°C	ISO 11358
Sharpy (notched, RT)	8,6	kJ/m2	ISO 179

Mechanical Properties

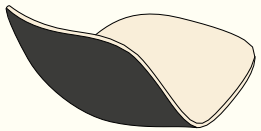
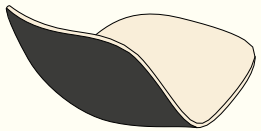
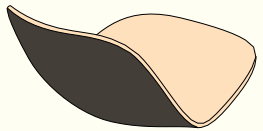
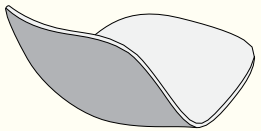
Tensile Modulus - 0°	18	GPa	ASTM D3039M
Tensile Stress at Break - 0°	150	MPa	ASTM D3039M
Tensile Strain at Break - 0°	1	%	ASTM D3039M
Tensile Modulus - 90°	10	GPa	ASTM D3039M
Tensile Stress at Break - 90°	90	MPa	ASTM D3039M
Tensile Strain at Break - 90°	1	%	ASTM D3039M
Flexural Stiffness - 0°	16,8	GPa	ASTM D7264
Flexural Failure Stress - 0°	156	MPa	ASTM D7264
Flexural Failure Strain - 0°	1	%	ASTM D7264
Compression Stiffness - 0°	17,9	GPa	ASTM D6641
Compression Failure Stress - 0°	154	MPa	ASTM D6641
Compression Failure Strain - 0°	>4	%	ASTM D6641
Compression Stiffness - 90°	10,3	GPa	ASTM D6641
Compression Failure Stress - 90°	146	MPa	ASTM D6641
Compression Failure Strain - 90°	>4	%	ASTM D6641

Strength material comparison

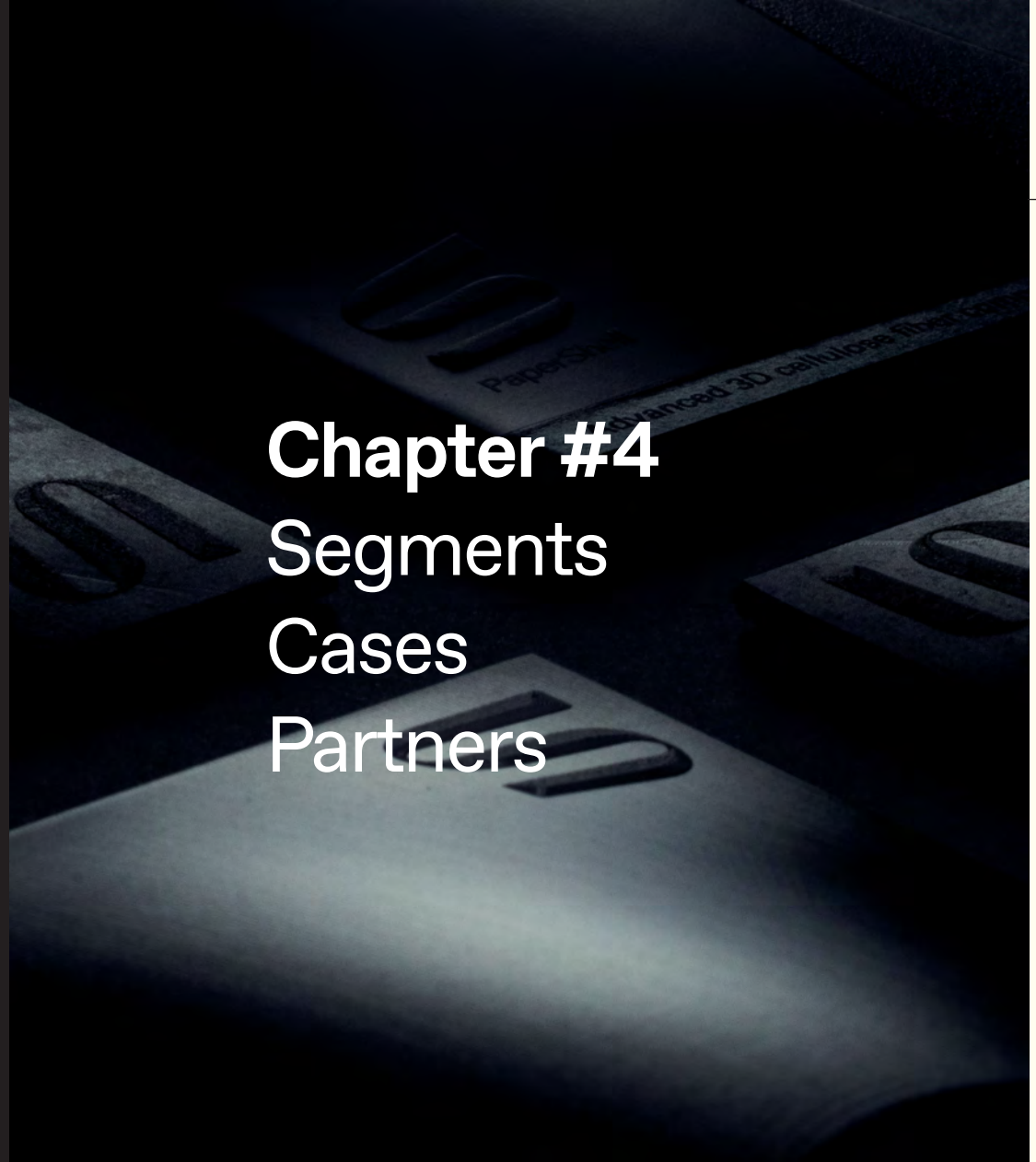


Ceramics: chart shows compressive strength, tensile strength typically 10% of compressive. **Other materials:** strength in tension/compression.

Material comparison
Reference case; Furniture seat component

	 **PaperShell[1]**	 **Wood (veneer[1])**	 **Plastics (PP)**	 **Glass fibre (GFRP)**	 **Metal (aluminium)**
Description	Press moulded composite material made from kraft paper and bio-based resins. Fossil carbon free with extremely low CO_2 footprint. A sustainable premium material.	Press moulded thin slices of wood that are glued together. Price range based on: 2D Veneer: EUR 35 and 3D Veneer: EUR 127	A fossil thermoplastic that can be reheated and recycled again[3]. Price range based on: Mid-and high range chairs: EUR 23-75 and Low-cost plastic chairs: EUR 7-23	Press moulded composite made from glass fibres and a plastic resin. Price range based on: Low-cost chairs: EUR 50-80 and Mid-and high range chairs: EUR +80	Press moulded aluminium component extracted from Bauxite ore requiring high amounts energy.
Thickness	**5 mm**	9 mm	5 mm	4 mm	2,5 mm
Weight	**2,2 kg**	2,7 kg	1,5 kg	2,6 kg	2,2 kg
Outdoors	**Yes**	No	Yes	Yes	Yes
Eco footprint	**Very low**	Low	Medium	Very high	High
Tooling cost	**Medium / High**	Low / Medium	High	Medium / High	High
Surface treatment	**Possible / Not needed**	Needed	Possible / Not needed	Possible / Not needed	Needed
3D possibilities	**High**	Low	Very high	High	Very high
Surface texture	**Very high**	Low	Very high	High	Medium

1. Based on cellulose fibre. 2. Unit price EUR for producing 10,000 chairs components with 50% mark up 3. Although it can be recycled, the recycling rate is low



Chapter #4
Segments
Cases
Partners

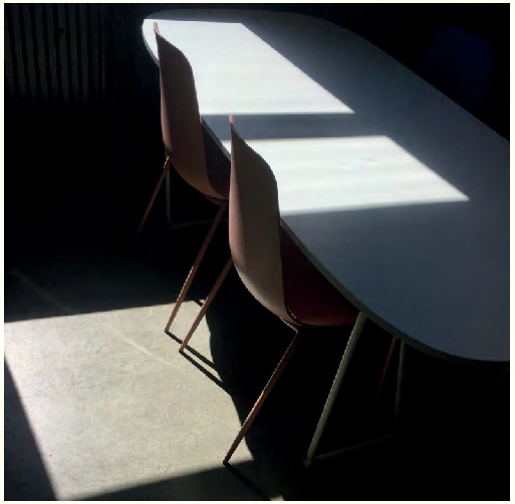
"Ongoing co-development projects and high demand from customers in all target markets with famous international brands and Fortune 500 companies. It might seem counterintuitive to target several markets in parallel, but the use cases are vast so the first years is all super-positioning a novel and groundbreaking bio-material and through cross-sectorial learning, find our hyper scaling sweet spot”

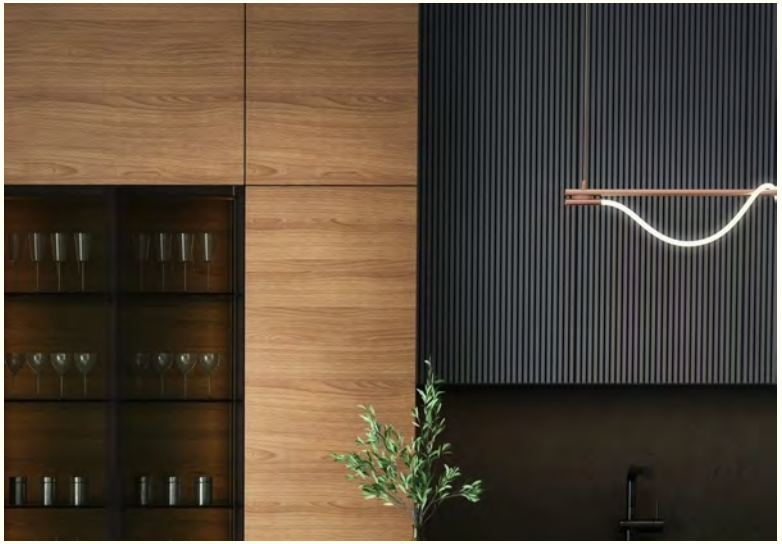
Consumer goods

Within the consumer goods industry plastics, fibre composites and laminates are frequently used. The quest for more sustainable alternatives is pursued by all major brands. Commitments to the market, consumers awareness and legislation is driving change towards more sustainable solutions. Materials contribute to their biggest negative impact. We have ongoing collaborations with several famous international brands and experts at present.

Interior

Within the interior and architecture market, material innovation and solutions towards a sustainable and circular economy industry is highly prioritised for B2B companies. We have ongoing projects with leading brands in Scandinavia and Europe. We will be launching projects in London at the Wired Impact event in November 2023.





As the projects are under NDA the pictures are only placeholders and are not representative of any specific project. They represent inspiration of potential market segments and applications.

Olsson Lyckefors Arkitektur + PaperShell

“We have been collaborating with PaperShell since day one and see huge opportunities for the material to impact the entire construction industry. It works both externally and internally on vertical and horizontal surfaces and with the possibility of freely shaping the material makes it extremely exciting as a means of architectural expression.”

—

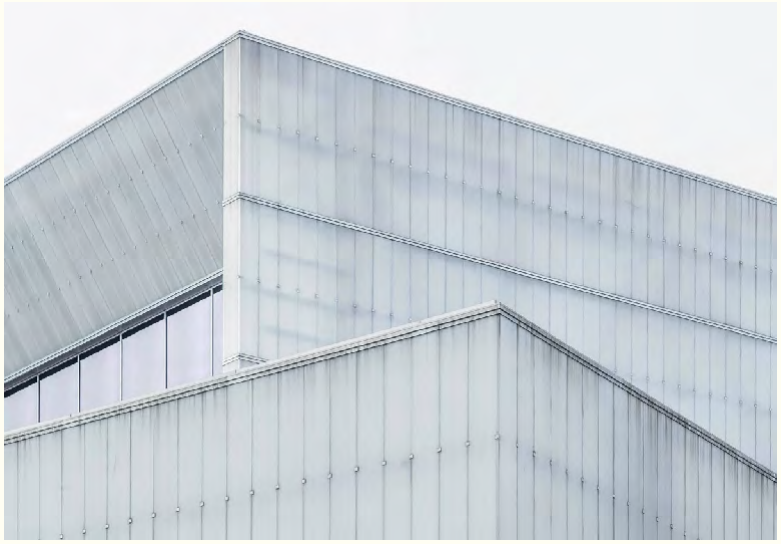
Andreas Lyckefors

CO-Founder, Partner, Arkitekt SAR/MSA

OLSSON LYCKEFORS ARKITEKTUR

Architecture

The construction industry has the highest negative impact on the environmental in Sweden and abroad. Within the architecture construction market, material innovation and solutions towards a sustainable and circular economy industry is highly prioritised for B2B companies. We have ongoing projects with leading brands and institutes in Scandinavia.



As the projects are under NDA the pictures are only placeholders and are not representative of any specific project. They represent inspiration of potential market segments and applications.

Arper + PaperShell

“When we met PaperShell, we realised that we were both aligned in wanting to build a more sustainable future. Given we share the same values, it seemed natural for us to decide to start this collaboration.”

—

Roberto Monti

CEO of Arper

Electronics + PaperShell

“This can change sustainability for the whole electronics industry at it’s silicon core! Replacing glass fibre, epoxy and flame retardants with PaperShell’s 100% fossil free bio-composites. I’m looking forward to never seeing a green PCB again, brown PCB’s is the new green and nature vs technology is not a zero sum game”

—

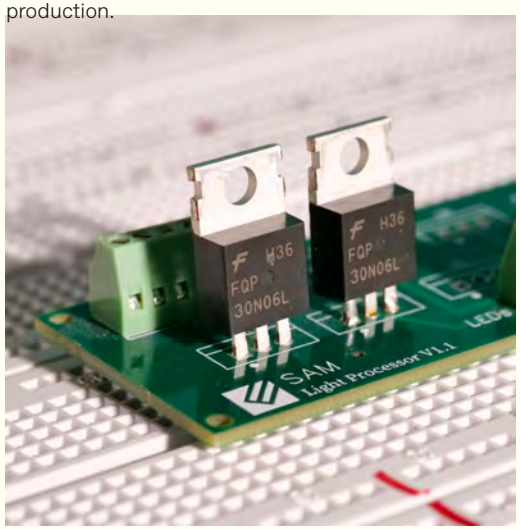
Marcus von Euler

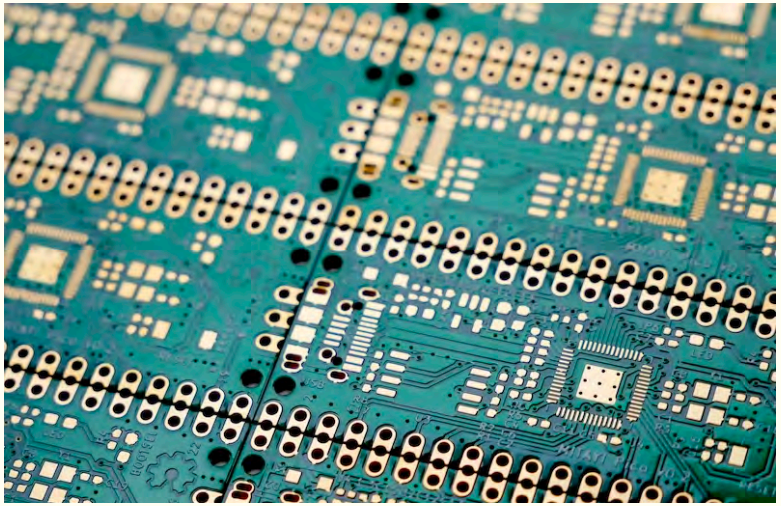
Awarded designer

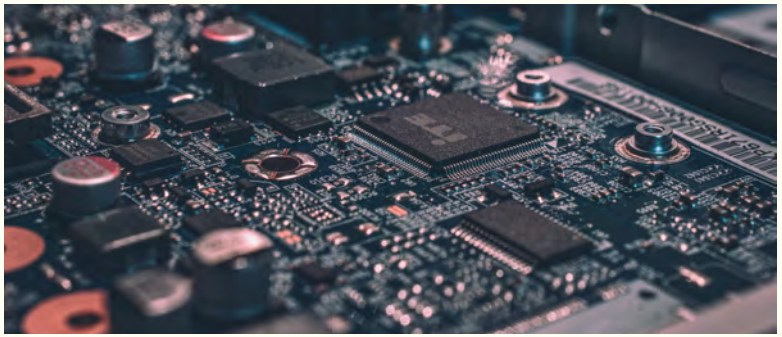
Co-founder of Marshall group (Zound Industries) & X Shore

Electronics

Within the electronics we are evaluating feasibility with both small avant garde SMEs, mid sized companies and have interaction with some of the worlds largest and most famous companies. We know this is hard but the interest is very high as the environmental impact of existing PCB substrates (FR4) are terrible as they are based on glass fibre, , epoxy and flame retardants.. On top of this the geopolitical situation makes it very interesting for corporations and public actors to secure and strengthen regional and local electronic component production.







As the projects are under NDA the pictures are only placeholders and are not representative of any specific project. They represent inspiration of potential market segments and applications.

Transport

Within the transport sector recycled, sustainable and light weight materials are high on the agenda. The holy grail is a material which can act both as a construction material as well as a surface material. PaperShell is presently being evaluated and has co-development projects with a number of global brand owners and fast moving avant garde companies in Sweden and abroad. We are spear heading with Polestar as they have publicly communicated that the are collaborating with us. We have also started our journey to became Automotive Production ready with the help of our collaboration OEM partners,

As the projects are under NDA the pictures are only placeholders and are not representative of any specific project. They represent inspiration of potential market segments and applications.

Polestar + PaperShell

“A project of this ambition requires partners at the cutting-edge of their industries and which are fully engaged in our bold vision. That’s why I’m looking forward to PaperShell becoming a crucial part of our team as we find solutions for developing an entirely climate-neutral supply chain. PaperShell’s expertise in advanced paperbased fiber composite will be invaluable in our mission and will play an integral role in pioneering new and innovative technologies to achieve what has so far been impossible.”

—

Hans Pehrson

Leader of the Polestar 0 project

Chapter #5
Markets Pricing Potentials

"Proven technology with highly automated production lines in place ready for commercialisation and ramp up. Present addressable market worth of approx. 85 bn USD market globally based on cost and CO2 performance. Potential to reach approx. 200 bn USD with 20% cost and CO2 reduction”

Total addressable market for PaperShell is USD ~570BN globally with a potential target market of USD ~200BN

Total market size 2022, bn USD		Description	Implication
Overall market	~1240	All materials in scoop that PaperShell can substitute, globally, across all industries	Plastics (PP, PC, PS, PVC, ABS), Carbon fibre, fiberglass, aluminium, flat steel and wood composites.
Addressable market[1]	~570	Applications where PaperShell solution technically and physically feasible[1]	Interior hard surfaces, structural elements with medium durability and strength requirements, parts with moderate cost pressure.
Target market (long-term)	~200	Industries where PaperShell products have economically and environmentally competitive applications.	Automotive, consumer goods, architecture, transport and electronics (circuit boards)

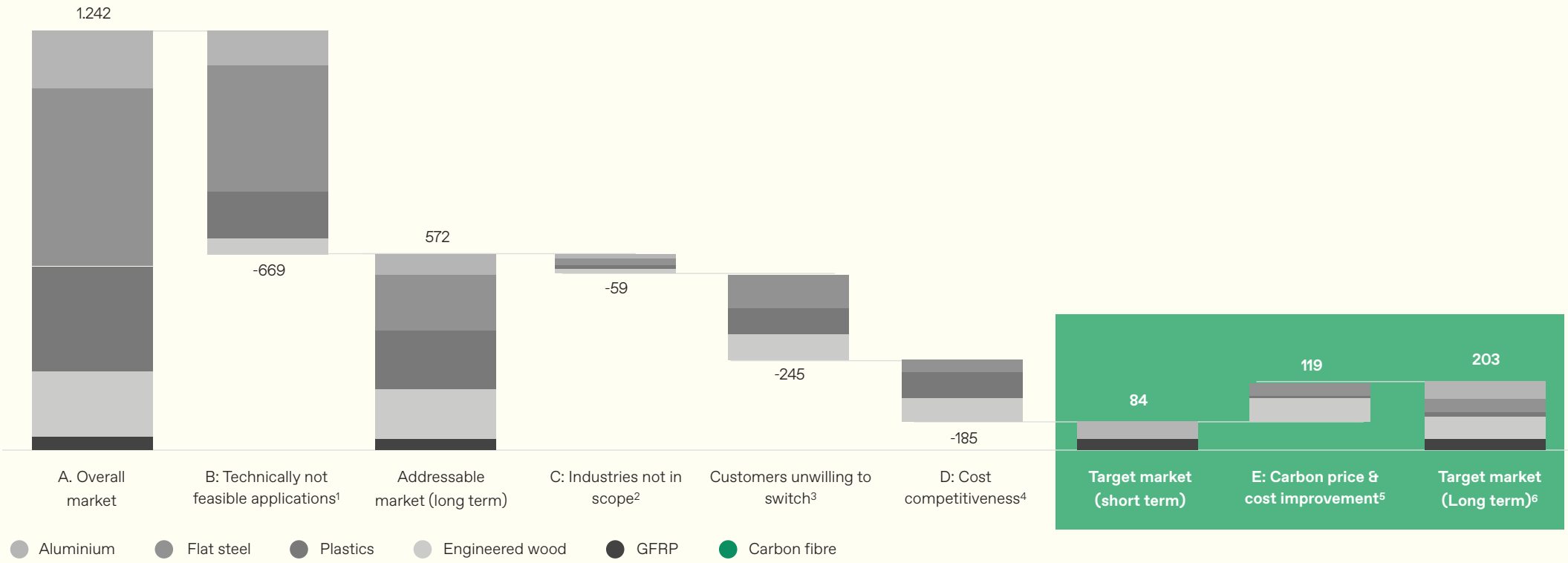
Addressable by PaperShell with today's type of products

1. Assessing technical feasibility based on the criteria listed on the next page; 2. To be estimated once core applications have been selected.

Today PaperShell has a target market of USD ~85BN - in the long term the target market could reach USD ~200BN

Total market size

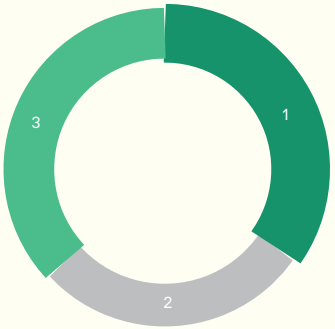
USD Billion



1. Based on material specific per industri applicability assessment carried out on previous page. 2. Limiting scope to automotive, consumer goods, built environment, transport and electronic. 3. Assuming only 30% of steel customers and 50% of engineered wood and plastics consumers are willing to switch to alternative material. 4. Based on today's cost adjusted for strength and density requirements needed to replace incumbent material. 5. Assuming a carbon price of 100USD/ton CO_2 for all materials but PaperShell and a 20% reduction in production costs for PaperShell compared to today. 6. Not accounting for underlying market growth and inflation.

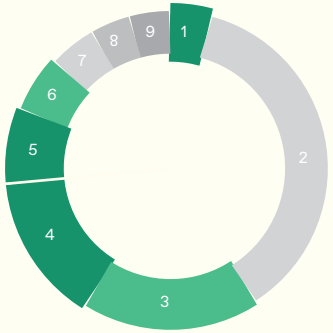
Target Market references and potentials

Press molded veneer
Contract furnishing market in Europe is poised to grow by USD 2.64 billion during 2020-2024, progressing at a CAGR of almost 3% during the forecast period. 3D veneers are now well established in Europe and have extended real wood veneers into applications previously dominated by plastics.



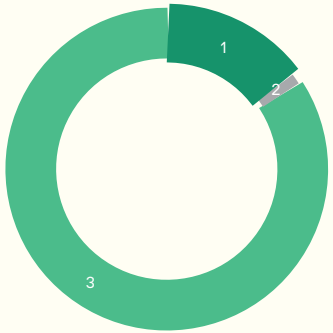
1. **Interior** [1]
2. Others
3. Construction [2]

Plastics
More than $30 trillion is currently held in sustainable investments around the world. The biodegradable plastics industry alone is expected to reach nearly $7 billion by 2025.



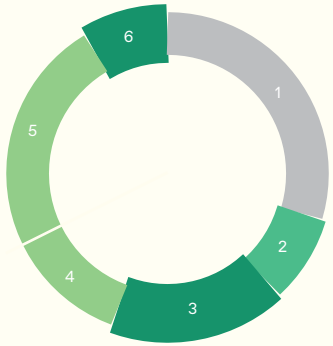
1. **Furniture and bedding** [1]
2. Packaging
3. Construction [2]
4. **Consumer goods** [1]
5. **Automotive** [1]
6. Electronics [2]
7. Others
8. Utility
9. Agriculture

Fibre composites
The global composites market size was estimated at USD 89.04 billion in 2019 and is expected to expand at a compounded annual growth rate of 7.6% from 2020 to 2027. The market is driven by increasing demand for lightweight materials. Increasing demand for composites in the automotive industry is anticipated.



1. **Biocomposites** [1]
2. Carbon fibre
3. Glass fibre reinforced plastics [2]

Aluminium
World production was 42.4 million tonnes in 2011. It trended steadily upward over the next decade to reach 65.3 million tonnes in 2020. Consumption of refined aluminium reached 58 million tonnes in 2020. PaperShell has half the strength of aluminium but also half the weight and can replace sheet aluminium.



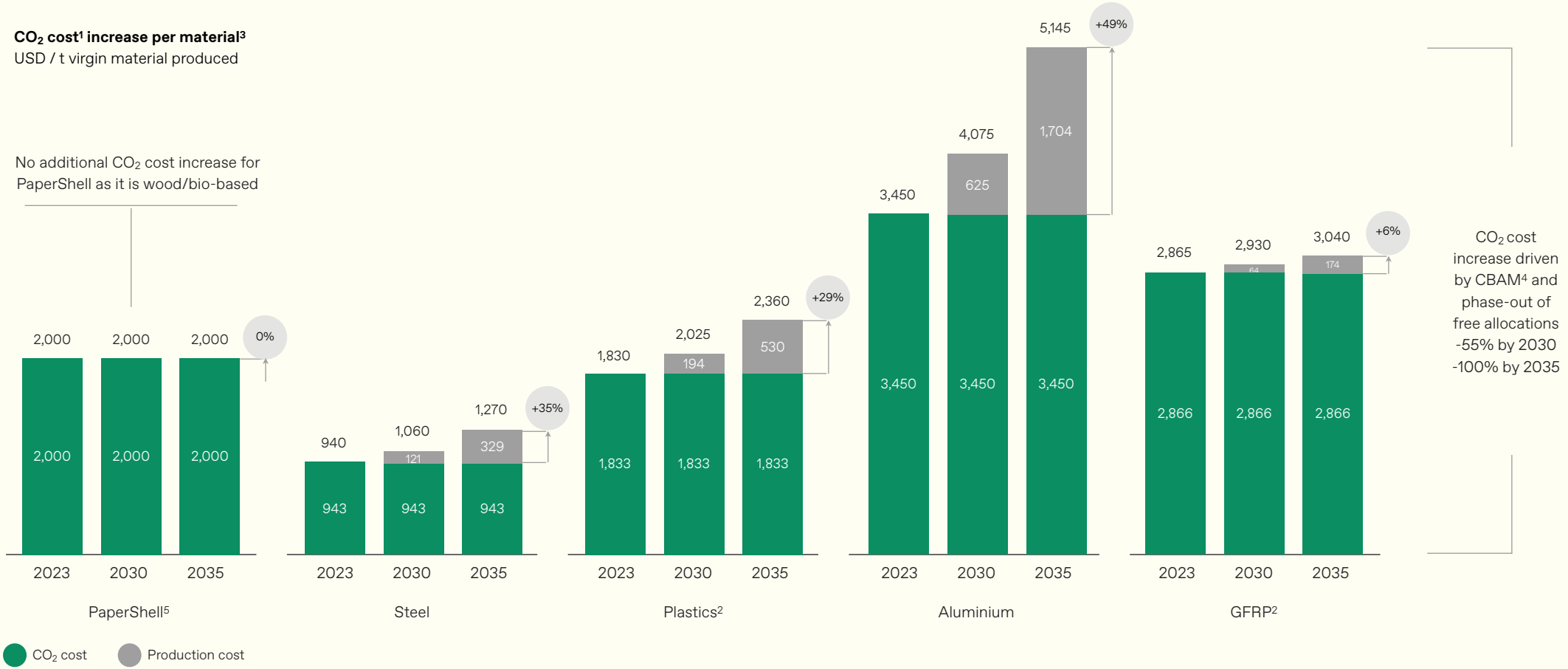
1. Heavy load structural applications
2. Lighter structural applications [2]
3. **Facades** [1]
4. Round hollow profiles / Pipes
5. Solid Profiles
6. **Body panels (exterior/interior)** [1]

[1] Primary segment
[2] Secondary segment

Sources: Technavio latest market research report titled Contract Furniture and Furnishing Market in Europe 2020-2024.
www.businessinsider.com, www.grandviewresearch.com, www.nrcan.gc.ca, svensktaluminium.se, www.statista.com

Additionally CO_2 Prices will increase, giving PaperShell an advantage

CO_2 cost[1] increase per material[3]
USD / t virgin material produced



1. Assuming CO_2 prices of 80 EUR/t CO_2 today (not visible due to free allowances), 100 EUR/t 2030 and 150 EUR/t 2035. 2. Based on ETS (Emissions Trading System) included for oil, production itself not covered directly.
3. Assuming constant emission factors for materials. 4. Carbon Border Adjustment Mechanism 5. Cost/tn PaperShell based on Input drivers binder and paper. No CO_2 costs appear for PaperShell.

Chapter #6
Branding
Marketing
Sales strategy

”Our brand is not just a logo, website or a design.
It's an experience. It's a sustainable story. Knowing why, what, how, when, and most importantly to whom, is essential for success of our brand, marketing and sales. The combination av art, design, engineering and science in together with our team’s and owners’ networks and access to key decisions makers is our greatest asset besides competitive products and services”

Partner promise - PaperShell's customer journey

Innovation & Science

Access to PaperShell's IP-protected technology and future roadmap.

Design & Engineering

Guidance and support from our experts in design, engineering and automated production.

Industry 4.0/5.0

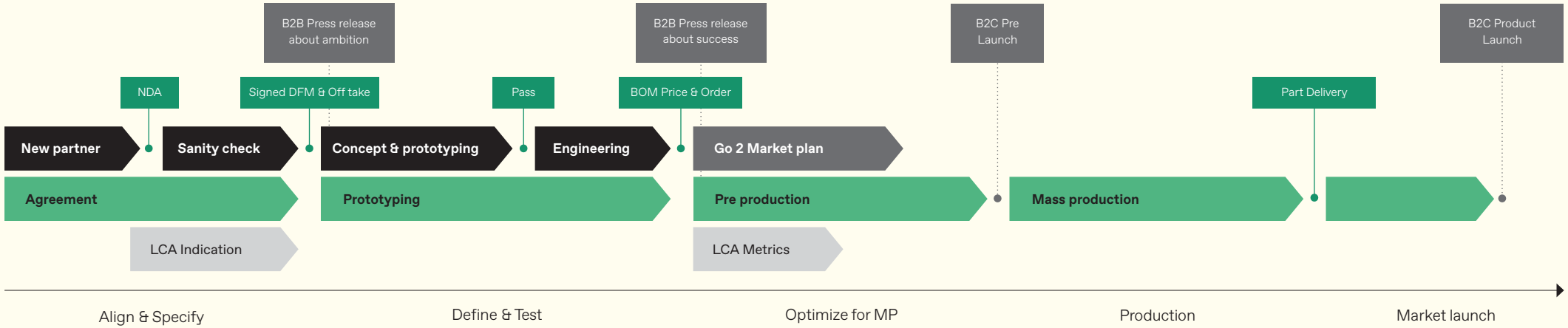
Highly automated, efficient and scalable production capacity with minimum ecological footprint. Made in Sweden.

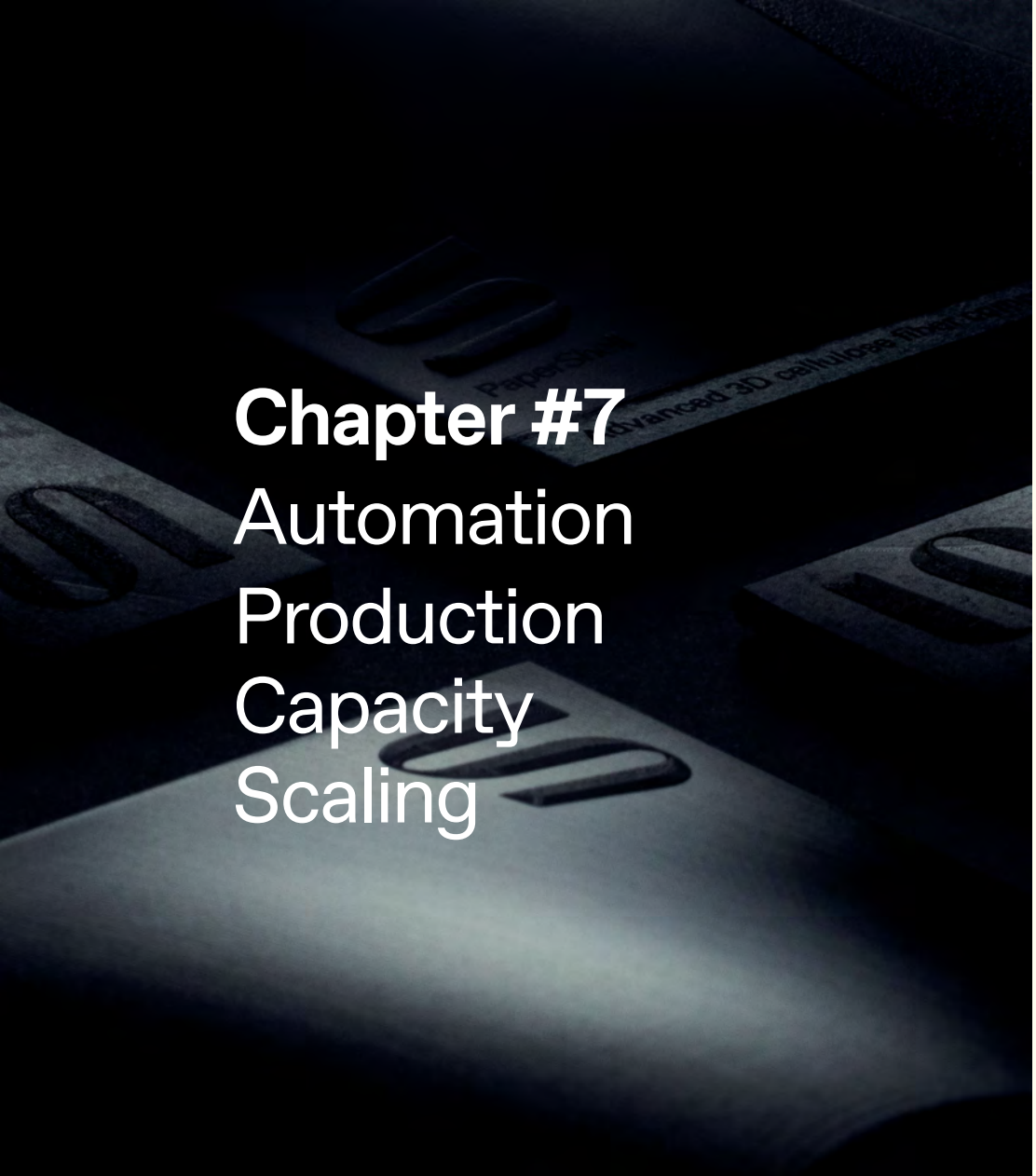
Traceability & cradle to cradle

Support with sustainability metrics (LCA/EPD) on every component for your sustainability ESG accountings. Assistance with circular economy systems solutions.

Communications & Co-Branding

Our co-branding kit supports your marketing team to leverage your sustainability communication.





Chapter #7
Automation Production Capacity Scaling

“PaperShells is a component manufacturing company thus state of the art production is paramount. This includes highly automated, efficient and scalable solutions. Our initial setup of the first three production lines prioritizes versatility and flexibility, enabling us to assess the most suitable product types and target markets as we scale up for mass production“

Production investments and scaling, flexibility to cost and production efficiency excellens

The production line concept, which has been developed, procured and will be installed (one small line is already installed in the Pilot Factory and two more lines: Medium and Large Q2 2024), offers an flexible and reconfigurable production set-up. It has the possibility to manage a wide range of different products and product size segments. Aiming for SMED1 in combination with high production output gives the possibility to work with both high and low volume products in a cost efficient manner already from the start. This enables us to work and evaluate several market segments in parallel at a lower scale. At the same time as we are industrialising, evaluating all details of the first production lines and ramping-up our OEE2 for successful target markets.

2024 starts during Q1 with finishing of the construction work of Factory 1 were the the M-Line and L-line will be installed and started up during Q2. Continuing through second half of 2024 and land into 2025, our primary emphasis will be on gaining deeper insights and expanding our production into targeted markets Enabling us to increase productivity, efficiency and production excellence. The coming production lines are being developed expedient for specific product segments or even to specific products. Limiting the flexility in the line concept and adapting machines to specific product segment requirements will allow multiple production efficiency.

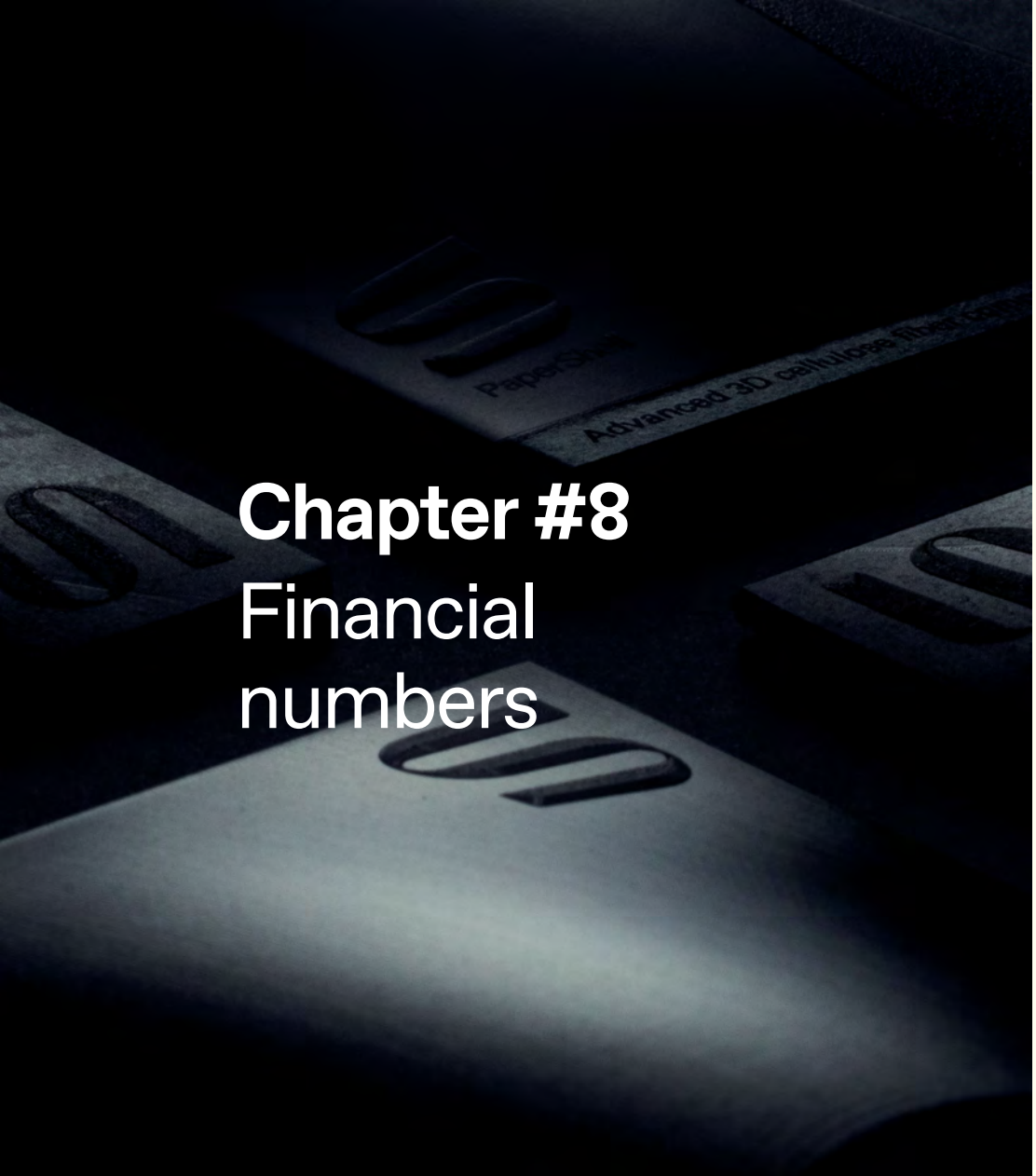
This signifies that as PaperShell production scales, it will not only increase in volume but also in operational efficiency. Flexibility will be kept, but for different types of products in different production lines where wastes successively will be eliminated. The full automation level with a minimum of direct labour cost, the overall efficient production lines in combination with high expected volume sales will reduce overall costs to enable us to compete with cheap fossil-based materials.

What we have already learnt is that PaperShell has developed an unique and impressive production set-up inspired by automotive, textile and composite industry tailored for the PaperShell material.

Taking into account all my years within manufacturing industry (14 years within global automotive Tier 1 supplier) and when I'm looking at the potential in all aspects of the production machinery, that we have developed, the material characteristics and the CO_2 emission reduction that PaperShells can provide, PaperShell offers exceptional operating leverage and is for sure the most promising and interesting potential I have ever experienced.

It was a great milestone to see the first small line run totally automated . Impregnated paper in one end and ready component in the other. To see in reality that not only did all our tests and simulations actually work, but also the initial measured OEE being higher than expected. I see huge potential.

Fredrik Westerberg
Chief Production Officer
PaperShell AB



Chapter #8
Financial numbers

”Finance consists of looking not merely at the immediate, but the longer effects, of any decision or action. Clear goals and measured outcomes creates stability and control. Business intelligence and decision support mitigates risks and increases the chance of success. Value creation and financial management must be applied on all levels of PaperShell.”

Investment road map

2021

- Seed and angel round approx. € 0.5 million
- Equity finance 1 approx. € 2 million
- Machine leasing (collateral) € 0.2 million

2022

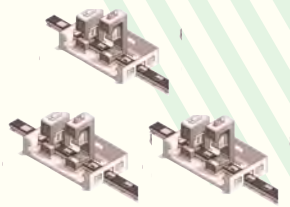
- Equity finance 2 approx. € 9 million
- Public funding, public loans & leasing € 1.8 million

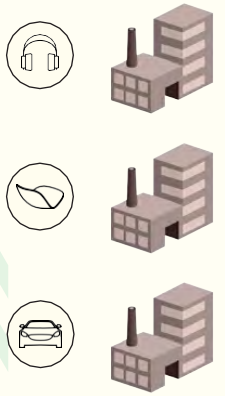
2023-24

- Bank loan
- Public loan
- Public funding
- Equity finance

2027

- Equity finance 4 / IPO € ~ 50 million
- Public, Bank € ~ 50-70 million



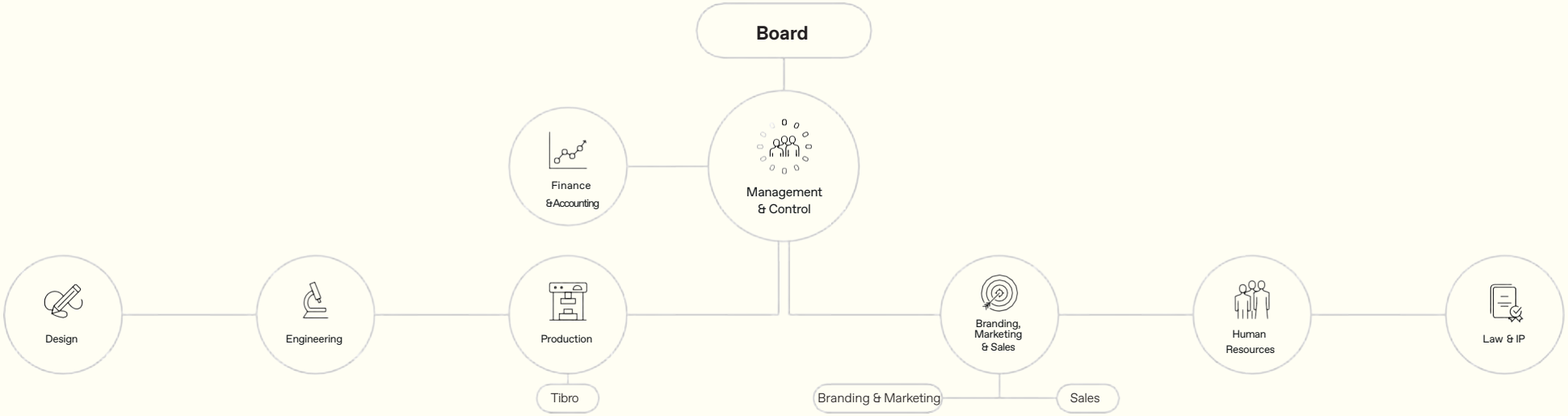


2030

Chapter #9
Our team

“Finding problems is probably the easiest task to do. Finding solutions, on the other hand, requires curiosity, knowledge, creativity, courage, perseverance, nerdiness, passion... and the power of diverse and talented teams.”

Organisation



Management & Control - Good management is the art of making problems so interesting and solutions so constructive that everyone wants to get to work and deal with them. Clear goals, tangible and realistic KPIs is key. But most importantly is our ability to communicate and support each other to excel to our full potential.

Production - PaperShells is a component manufacturing company thus state of the art production is paramount. This includes highly automated, efficient and scalable solutions. By cross breeding knowledge from different industries we constantly strive to be as sustainable and competitive as possible.

Engineering - Engineering, research and development spans over micro and macro level. From chemistry to computer simulations. Securing needs and wishes from clients. And challenging ourselves to explore and to enhance our role as a pioneering science based company.

Design - Art and design is at the very core at PaperShell. Perception of value and quality is a key success factor for our target markets and brand strategy. This includes color, material and finish exploration, internally and together with partners, to secure and maximize value for our clients and PaperShell as a whole.

Branding, Marketing & Sales - Our brand is not just a logo, website or a design. It's an experience. It's a sustainable story. Knowing why, what, how, when, and most importantly to whom, is essential for success of our brand, marketing and sales. Our ability to create, package, communicate and measure is essential.

Human Resources - The ultimate resource is people. Finding, attracting and keeping talents is key. We believe in diversity, constant development and continuous learning. PaperShell strives to be an attractive employer cultivating motivated, passionate and professional teams. An agile mindset with a modern and sustainable work life as our mission.

Law & IP - PaperShell have developed competitive IP and other legal assets for several years and continue to do so. Adequate control over critical knowhow and projected revenue streams for actors in the business eco system, putting the IPRs into use as a means to make the business grow.

Finance & Accounting - Finance consists of looking not merely at the immediate, but the longer effects, of any decision or action. Clear goals and measured outcomes creates stability and control. Business intelligence and decision support mitigates risks and increases the chance of success. Value creation and financial management must be applied on all levels of PaperShell.

Managers

Anders Bergström
Head of Design
(~0,34% ownership, 180 warrants)
17y of experience in design within the automotive industry

Cecilia Karlsson
Chief Operating Officer
(~0.03% ownership, 90 warrants)
14y of experience in communication, project management, public funding and promoting sustainable and circular manufacturing.

Fredrik Westberg
Chief Production Officer
(~0.09% ownership, 110 warrants)
14y of experience in production within manufacturing industry

Karin Ljung
Chief Financial Officer
(60 warrants)
+15 y of experience in forestry industry and renewable energy sector.

Anders Breitholtz
CEO & Co-founder
(~18,9% ownership)
+20y as consultant within material tech strategies and resource management

Anders' has devoted his professional life to mapping, scouting, sourcing, implementing and designing sustainable, innovative and advanced materials and production techniques for Avant-garde Unicorns and Fortune 500 companies cross market. After 20 years of working as a material tech scout, he founded the fast growing biotech company PaperShell based on his knowledge about the demand for sustainable bio materials, circular economy and the lack of viable large-scale solutions that enables companies to reach Agenda 2030 and beyond.

Anders Holmqvist
Chief Technical Officer
(32 warrants)
25y of experience of advanced materials

Mina Rad
Head of Brand & Marketing
(~0.02% ownership)
10y of experience in marketing and project management

Tanja Lundberg
Chief Sales Officer
(~0.03% ownership, 20 warrants)
Several years of experience in project management & sales B2B

Boards of directors

Ragnhild Wiborg
Chairman
(~2.3% ownership[1], 656 warrants)

Board member of Intrum AB, Kistefos ASA, Rana Gruber and EWS Foundation. Chair of the Board of Energia ASA ,Cerebrum Invest and of Wiborg Kapitalförvaltning AB. Previous Boardpositions of Gränges AB, Borregaard ASA, Sbanken ASA, Cary Group AB and RECSilicon ASA. Other previous positions: partner/Chief Investment director and Fund Manager in Odin Fund management and Wiborg Kapitalförvaltning. Several positions in a number of investmentbanks, including Pareto, ABG Sundal Collier, First Chicago (now JP Morgan) and SEB.

Anders Breitholtz
Board member & Co-founder
(~18.9% ownership)

Anders' has devoted his professional life to mapping, scouting, sourcing, implementing and designing sustainable, innovative and advanced materials and production techniques for Avant-garde Unicorns and Fortune 500 companies cross market. After 20 years of working as a material tech scout, he founded the fast growing biotech company PaperShell based on his knowledge about the demand for sustainable bio materials, circular economy and the lack of viable large-scale solutions that enables companies to reach Agenda 2030 and beyond.

Mathieu Gustafsson
Board member & Co-founder
(~13,7% ownership)

Mathieu has a cross-disciplinary background encompassing product design, branding and sustainable materials development and implementation, with an emphasis on product design and sustainable production for the furniture industry. After numerous years of developing a kindred natural fibre composite for the furniture industry.

Christopher Carrick
Board member
(~9.3% ownership[2], 90 warrants)

CEO Of Lignin industries. Lignin industries started 2018 with the idea of converting lignin from pulp mills to biomaterials that replace fossil plastics. Lignin industries is a Swedish innovation company. Christopher have a family history of five generations of pioneers within the Pulp and Paper industry. Including founding SCA to establishing and managing several of Sweden's most famous Pulp and Paper production plants.

Mille Milehem
Board member
(~0,7% ownership[2], 90 warrants)

Vice President / COO Input Interior. Input interior is the Nordic region's leading independent interior design group with unique expertise within needs adapted solutions for offices and businesses, hotels and restaurants, schools and healthcare and reused furniture for contract market. The group turnover is approximately €330 million and among Input interiors customers you can find many of the most successful businesses and companies in Europe. Since 2018 Mille is member of the board in Länsförsäkringar Älvsborg (Insurance and Bank).

Mats Torring
Board member
(~12.1% ownership[3], 90 warrants)

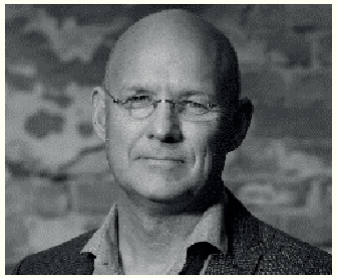
Board member and Head of New Ventures Stena Metall AB. Stena Metall Group has seven business areas and operations at around 200 locations in nine countries. Each year, six million tons of waste and end-of-life products are recycled and refined, and customers are supplied with many essential raw materials, steel products and marine fuels.

1) Ownership through Cerebrum Invest 2)~8.9% ownership through Pul Paper Machinery Dick Carrick Invest, ~1.4% direct 3) Ownership through Stena Ventures

Boards of directors

Carina Andersson
Board member
(~0,03% ownership, 20 warrants)

Board member of Systemair AB and Detection Technology Oyj. Chair of the Board of Returpack AB and Carbomax AB. Previous Board Positions of Mälardalens University, Sintercast AB, BE Group AB, Gränges AB, Swedish Stirling AB and Beijer Alma AB. Other previous positions: Senior positions at Sandvik Materials Technology AB, CEO Ramnäs Bruk AB and Scana Ramnäs AB.



Jonas Roupé
Board member
(20 warrants)

Jonas Roupé is an industrial strategist and Circular Economy/Sustainability Expert. He has held key positions at the European Tyre and Rim Association (ETRMA), Ragn-Sells, and TeliaSonera. Jonas is also a co-founder of End Ecocide Sweden and currently chairs the boards of Cradlenet, Swedish Tyre Recycling AB (SDAB), and Rädda regnskog — an NGO focused on rainforest restoration.

Anders Bergström
Adjunct member
(~0.3% ownership, 180 warrants)

Board member and former Chief Designer / Senior Design Manager advanced materials at global OEM Car Companies. Has worked with Colour Material Finish (CMF) on more than 20 production cars, concept cars and facelifts. 17 years of work experience from Car companies in Europe, China and US. Expert designer of automotive innovative materials interior and exterior design, material and supplier decisions. Large global network within both design and automotive supplier.

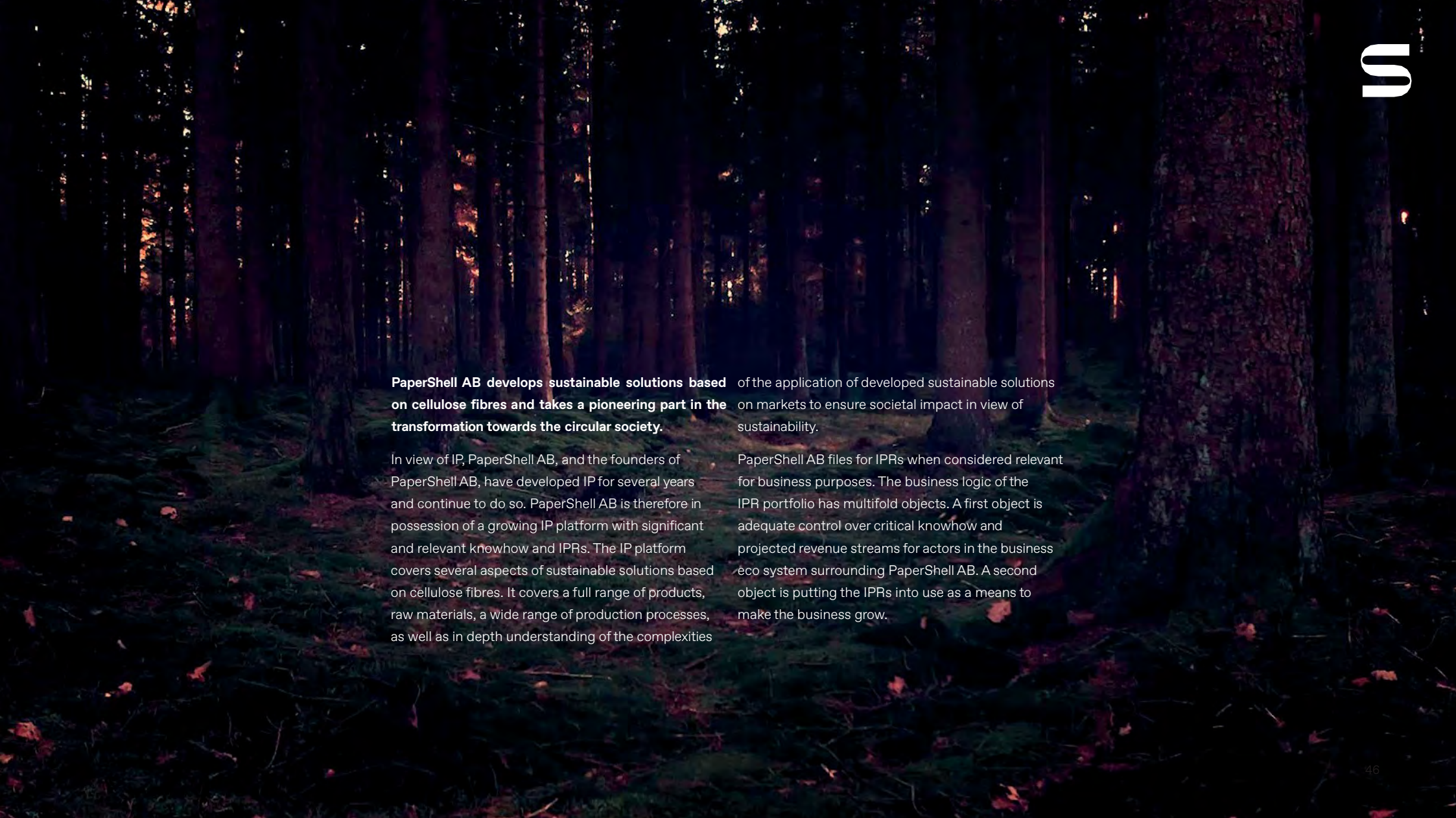
Advisory board

Gunnar Brock
Board advisor
(~0.5% ownership)

Chairman of the Board of Stena AB and of Neptunia Invest since 2017. He is also board member of Investor AB and ABB.

Staffan Bohman
Board advisor
(~4.1% ownership)

Chairman of the Board of Electrolux since 2018 and board member of Atlas Copco. Previously CEO of Gränges, Sapa AB och DeLaval.



PaperShell AB develops sustainable solutions based on cellulose fibres and takes a pioneering part in the transformation towards the circular society.

In view of IP, PaperShell AB, and the founders of PaperShell AB, have developed IP for several years and continue to do so. PaperShell AB is therefore in possession of a growing IP platform with significant and relevant knowhow and IPRs. The IP platform covers several aspects of sustainable solutions based on cellulose fibres. It covers a full range of products, raw materials, a wide range of production processes, as well as in depth understanding of the complexities of the application of developed sustainable solutions on markets to ensure societal impact in view of sustainability.

PaperShell AB files for IPRs when considered relevant for business purposes. The business logic of the IPR portfolio has multifold objects. A first object is adequate control over critical knowhow and projected revenue streams for actors in the business eco system surrounding PaperShell AB. A second object is putting the IPRs into use as a means to make the business grow.