FACING FUTURE

MAKING OUR BOATS MORE SUSTAINABLE—FROM DESIGN AND BUILD THROUGH HOW WE SAIL THEM—IS TAKING BOATBUILDING IN NEW DIRECTIONS.

PHOTOS BY JOZEF KUBICA FOTOGRAFIE

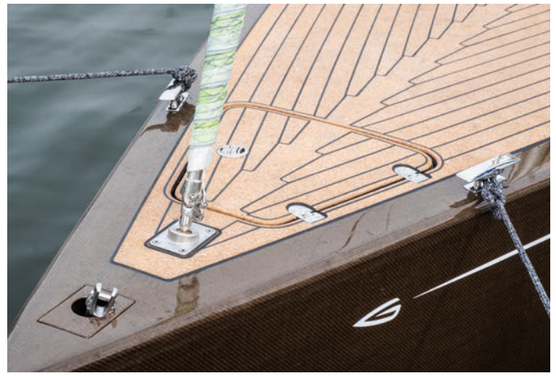
In 1942, Ray Greene and Company changed the face of boatbuilding when they built the first viable polyester-fiberglass composite boat. These materials meant that boats could be built cheaper and faster than traditional wood hulls, and new shapes became plausible. The decades that followed were revolutionary for the sport and the industry as sailors flocked to these boats, which builders promoted as low maintenance and easy to repair.

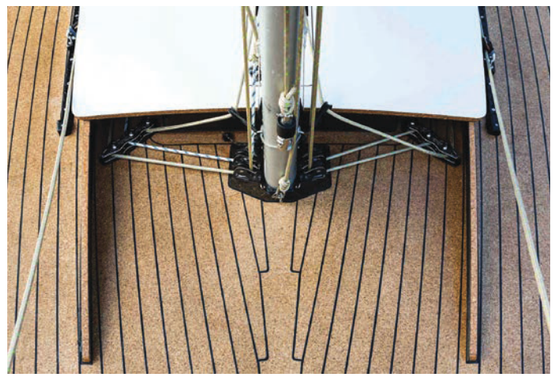
Boatbuilding has evolved since then, yet much has remained the same. Today, most sailboats are built using sandwich composite construction—a lightweight core is bonded between two thinner composite layers, providing stiffness at reduced weight. While the core may be an organic material like balsa, the composite layers consist of a reinforcement (usually fiberglass or carbon fiber) and a matrix (resin, such as epoxy). Glass and carbon fibers alone are flexible, easily scattered, and porous; their power lies mostly in their strength-to-weight ratio when put in tension or compression. When combined with a stout resin—a material with great adhesion properties but that is relatively brittle on its own—we achieve a composite material that is strong, impact-resistant, and capable of being formed into complex shapes such as hulls and decks.

We also create something that is bonded in such a way that its components are not easily separated, and this fact limits the options for dealing with a boat at the end of its life cycle. In most cases, after being stripped of anything of value, a hull is cut up, crushed, and dumped in a landfill. While fiberglass should break down to its natural components within 50 years, it is encased in a synthetic petroleum-based resin that will effectively never biodegrade.

Limited programs exist to try to do more as landfill space shrinks: convert hull fragments into alternative fuel for industry, add composite grindings to mediums like cement as reinforcement, and pyrolysis—a process that chemically recovers substances under high heat, providing petro-fuels. These options ultimately contaminate the air we breathe or push the problem farther down the road, and not necessarily in a cost-effective way.

With an aging sailboat population numbering near 1.6 million in the U.S., and over 2.5 million worldwide, sailboat owners and the boatbuilding industry have a large issue to solve. Many in the industry are already deeply involved in studying techniques and materials to





GreenBoats' Flax 27 is a composite of flax fibers and infused resins that are partially bio-based, left. Cork decking, above, also enhances this boat's end-of-life recyclability. The Germany-based company also makes flax components for the IMOCA 60s that are competing in The Ocean Race.

SUSTAINABILITY AND SAILS

The headsail and customized mainsail of the Spirit 44CR are built by OneSails in a material called 4T FORTE, developed to be a more sustainable material; the glue and mylar technique traditionally used to make performance sails is replaced by a heat fusion approach, generating a lower level of CO2 emissions and eliminating the weak elements of laminate sails.

These sails use a high-modulus grid to handle primary loads and oriented microlayers to provide strength in secondary directions. This is all fused between ripstop layers and is not only stretch resistant and durable, but lighter than traditional laminate sails and UV resistant on its own. The base polymer is recyclable in a waste separation process, ultimately turning into a polyethylene pellet that can be used to produce accessories for new sails, such as headboards.

Other sailmakers are also making headway towards a better future. Elvstrøm Sails, featured on Windelo Catamarans, offers their EPEX membrane sails that are made from 100% recycled polyester fiber and a recycled taffeta. Labeled under the sub-brand EKKO, these sails are produced in their loft that is entirely run by wind generated electricity. They also purchase wind energy credits to cover the electricity used by their suppliers outside of Denmark. Supported by research from the University of Copenhagen, Elvstrøm Sails have switched to heating their loft with wood chips as a more environmentally friendly approach.

Quantum has launched their EcoSeries of sails, along with going 100% solar powered in their primary Sri Lanka manufacturing loft. North Sails is deep into a life cycle assessment of their products that will allow them to focus further on decreasing their footprint.

design a future that avoids today's problems. We can take that a step further and recognize that this end-of-life issue points to a much larger environmental concern: the full life cycle impact of sailboats. That is, not only how we build our boats, but also how we sail them.

Sustainable boatbuilding is about creating boats that pay respect to the environment through every step of their lives. Organic materials, like flax and hemp rather than fiberglass, and bio-influenced resins rather than fully petroleum-based epoxies, hold some promise. But materials are only one part of a much larger sustainability picture that demands a multi-pronged approach—examining everything from analyzing and reducing emissions from the energy required to run a boatbuilding plant to balancing the benefits of natural fibers against the detriments of added weight that affects performance. While by no means exhaustive, what follows is a look at how some builders are tackling these challenges, and how we, as sailors, can play a greater role to drive change as well.

Baltic Yachts

Anders Kurtén, Baltic Yachts CEO, says an impact assessment is a critical first step. Boatbuilding materials such as carbon and resin are significant, but other manufacturing factors can easily eclipse their impacts. Tackling the largest offenders first will move a builder to being more sustainable faster.

"It takes time to get the measurement battery in place to correctly understand environmental impact, and without that we would be navigating blindly," Kurtén says. "First, we needed to understand our footprint, and then we could begin to set productive goals."

In the last four years, Baltic has reduced its manufacturing CO2 equivalents by 66%—down to 400 metric tons annually. Measuring manufacturing impact, they knew to focus on heating and electricity usage first, shifting to all wind farm generated electricity and replacing fossil fuels with pellets for heating. Baltic is also on a path to reduce waste and is handling anything remaining with a strong focus on re-use and recycling, using organic materials for building molds and other infrastructure. Kurtén notes that the harder areas to manage include freight and outside equipment vendors, but Baltic is applying pressure to get them on a similar path.

Baltic has also focused on how people use their boats. While variable, Kurtén says that one of their sailing vessels, powered by an internal combustion engine, generates around 30 metric tons of CO2 per season (burning about 10,000 liters, or 2,641 gallons, of fuel—not unrealistic for a 60- to 80-foot boat with a 150- to 300-hp engine, respectively). With their boats estimated to last more than 50 years, and factoring in replacement equipment over a yacht's life, this translates to an impact that well exceeds that of the manufacturing process.

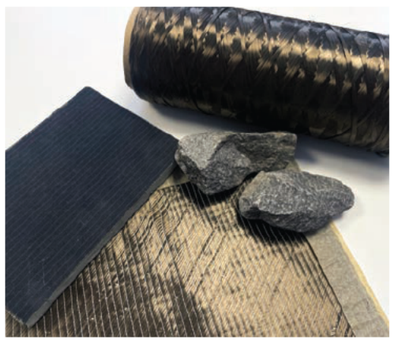
To encourage owners to sail more and motor less, Baltic remains committed to building performance-oriented boats that are enjoyable to sail through a wide range of conditions. New boats have a hybrid electric propulsion system—though the ultimate goal is full electric, as on Baltic's 68-foot Café Racer. They believe this will be accomplished through better clean energy storage options, coupled with overcoming cultural mindsets.

Baltic's hybrid systems can generate 15-20 kW of energy sailing at 13-15 knots. However, they estimate that their vessels are anchored or at the dock 90% of the time, when supplying adequate power would mean more solar panels than the yacht can reasonably fit. This calls for more responsible power consumption, which becomes even more challenging in darker, colder climates. Kurtén stresses that this stationary footprint should be a strong focus for all builders.

The Café Racer, launched in 2021, has also served as a test bed for alternative building materials. Baltic began exploring flax fibers as a reinforcement more than 10 years ago and started using it in non-structural applications seven years ago. The Café Racer is comprised of over 50% flax reinforcement in the hull and deck. Custom prepreg flax and carbon laminates were laid strategically to reduce the yacht's overall carbon footprint, using flax in lower-load areas. Flax fibers also absorb vibration and assist in sound deadening.

Kurtén says that "many organic materials, flax among them, are prone to moisture-related structural deterioration. However, the flax [Baltic] uses is exclusively as prepregs, which means that the fibers are [already] 100% impregnated with epoxy resin, and as the components are cured in an oven under vacuum, the resulting composite structure becomes, in essence, completely sealed and stable…even if the structure becomes severely damaged there is no possibility of capillary action spreading the moisture in the structure." Baltic also employs non-destructive scanning to ensure that the cured structural pieces have 100% integrity.

The development team has been closely monitoring bio-resins, but the available products are not up to their standards yet. Baltic



Groupe Beneteau's First 44 built using a new recyclable resin, top. Bottom, left to right: Volcanic rock is used to make the basalt fiber employed by Windelo Catamarans and Innovation Yachts; the Innovation Yachts Open 60 under construction and under sail.

PHOTOS BY GILLES MARTIN-RAGET. COURTESY OF GROUPE BENETEAU (TOP). WINDELO CATAMARANS (BOTTOM)

PHOTOS COURTESY OF INNOVATION YACHTS (LEFT) CHRISTOPHE FAVREAU (RIGHT)

Baltic Yachts' 68-foot Café Racer has more than 50% flax reinforcement in lower load areas. Cork decks are even grippier than teak, left.

has an excellent reputation for building yachts that endure the test of time; shortening their lifespan isn't an environmentally helpful option in the company's eyes. The company has been closely following recent laboratory work that has proven that fibers can be recovered from non-bio-based resins. While likely still 7 to 10 years out from commercial implementation, this technology holds promise for making high-modulus materials, like carbon fiber, more sustainable (as there is yet to be a natural-fiber reinforcement that matches the strength and weight of carbon fiber).

Even when using organic materials, sourcing is another element of the sustainability equation. Baltic has explored non-tropical woods for decks and through extensive testing has found few viable alternatives beyond synthetics (which carry their own issues). However, they did land on one excellent alternative for teak decking: cork. Bonded cork feels better than teak and carries better grip. They do note that it is not quite as durable, but for a more sustainable product that reflects a traditional appearance, it's worth the tradeoff.

Outremer Catamarans

Outremer echoes and amplifies Baltic Yachts' focus on performance. Xavier Desmarest, co-founder and CEO, believes in achieving a higher level of sustainability through creating a boat that sails more often, instead of motoring.

According to Outremer's research, the trick to that is light air performance: Most sailors won't start sailing in anything under 10 knots of breeze or anything over 25 knots, because their boat isn't enjoyable in those conditions. Desmarest explains that the western Med only sees those conditions 31% percent of the time. But, with a performance-oriented boat that sails comfortably in as low as 5 knots of breeze, that sailing window shifts to an impressive 90%.

While conditions vary across the world, light air is far more frequent in my experience. In my backyard, the July 2022 NOAA data from Buzzards Bay tower in Massachusetts provides another point of reference. The average windspeed was 12 knots, and 60% of the time the wind was between 10 knots and 25 knots. The wind was between 5 knots and 25 knots 89% of the time. So, even in a location with a great summer sea breeze, good sailing performance between 5 and 10 knots of wind means 50% more enjoyable sailing time. Desmarest has an excellent argument for sustainability through performance.

These performance characteristics are made a reality in Outremer's shop. Like other builders, they turned to MarineShift360, a life cycle assessment tool, to gauge their impact. They have found that it works well as a first assumption, and then custom tools backfill to create a more accurate picture. This has taught them that the use of their boats accounts for 75% of the impact footprint.

So, while Outremer has built a 60-foot catamaran out of 50% flax fibers that can not only cross an ocean but also grab a podium finish (Roland Jourdain, Route du Rhum 2022), they are even more focused on how they can reduce emissions while underway. They strive for installing closed-loop propulsion systems that can replenish while underway and on the hook.

Outremer has spent considerable development time on natural reinforcements and bio-resins, but they have found that there isn't much available for a smaller boatbuilder. And, nothing yet competes with carbon fiber for stiffness and strength. A move in any other direction sacrifices performance, increasing the environmental impact.

Desmarest admits that assessing impact is not absolute. It can often be tough to tell what is good. Every aspect carries layers, and incomplete information is common. He believes it is important to take a sincere look at what can be measured.

Innovation Yachts

A new natural fiber has taken hold at Innovation Yachts in Les Sables d'Olonne, France. In 2009, founders Marion and Norbert Koch began experimenting with volcanic fibers as a high-end recyclable reinforcement. They found a basalt-based solution that is hydrophobic, UV resistant, exhibits good shock impact, and contains high tensile and compressive strength. To produce it, volcanic rock is refined, melted down, and extruded into fibers, which are then incorporated into a fabric for boatbuilding.

Combined with a bio-based resin, this material is recyclable; Innovation shreds and integrates it into isotropic products in new builds, such as filler used for fillets and bonds. The resin is produced by BTO Epoxy in Austria and aims to avoid sacrifices in performance, while remaining bio-based and recyclable. A dry-fiber analysis, provided by 11th Hour Racing, suggests the mechanical properties of basalt fibers fall close to e-glass fibers and well above flax.

Like other builders, Innovation Yachts considers core materials for environmental impact. Forest Stewardship Council (FSC)-certified carbon-neutral balsa is their primary material, followed by cork and recycled Airex foam core. Each offers different mechanical properties and is allocated based on load demands.

Their vessels would not be complete without electric drives as the only auxiliary propulsion option. Hybrid systems (using a generator) are outfitted for certain cruising applications, especially in higher latitudes. Norbert Koch, also managing director, knows that their boats are not perfectly green, but feels that, "It is better to admit to small steps and improvement with intention, avoiding all too common greenwashing."

Windelo Catamarans

Windelo, launching their first sailboat in 2018, is another builder using basalt fibers. They found it to be a long-life material with a smaller footprint than fiberglass. Gautier Kauffmann, co-founder, says that "using flax would require more fibers due to the difference in mechanical properties, with resin usage compounded by the flax fibers not being as smooth as basalt. Lighter means less energy is used to propel the boat, and sailing also starts at lower wind speeds of 3 knots true. With speed, hydrogeneration is easy—at 10 knots of boat speed, each drive is generating 1 kW."

For a core material, Windelo turns to recycled PET (polyethylene terephthalate, commonly used to make plastic bottles) which is presented as half of the carbon footprint of virgin PVC foam. Kauffmann explains that PET's shear strength is less than PVC, so 80 kg/m3 of PVC is equal to 120 kg/m3 of PET. Divided appropriately by structural need, 45% of their catamarans are PVC and 55% is recycled PET. They could use 100% PET, but that would require higher foam density, which translates to more weight, which is not eco-friendly for the boat use.

Windelo, similar to other builders focused on performance, even optimizes interior furniture, creating a lighter composite with two-layer FSC plywood placed on either side of PET foam. In sourcing these materials, Kauffmann keeps in mind that bio-sourced does not necessarily mean eco-friendly; each decision requires due diligence.

A large roof on Windelo catamarans means lots of solar: 4.5 kW on the 50 and 54 models, which is soon to be upgraded to 5.5kW on the new versions. If production of green energy is increased, so is the powering range without using a generator.

Spirit Yachts uses meticulously sourced woods in their traditional construction techniques, above. The Spirit 30 is coated in an outer skin of flax, rather than traditional fiberglass, using a bio-based resin.

PHOTO BY STUART PEARCE @YACHTSHOT

PHOTO BY WATERLINE MEDIA

Groupe Beneteau

As the largest player in sailboat manufacturing, Groupe Beneteau has the power to drive change with volume. Sailboat Product Director Damien Jacob says that "they are dedicated to improving the entire environmental life cycle of future boats. Building at scale, with a new process, is the current challenge." Scale means a full production floor. So, they are starting with building specialty yachts and components.

Groupe Beneteau is trialing a recyclable resin. Elium, manufactured by Arkema, is a thermoplastic resin that contains 20% recycled content and seemingly matches the strength and weight of traditional epoxy resin. At the end of life, it is designed to be compounded (ground down and mixed with a virgin matrix) or depolymerized (chemically separated from the fiber and reused in new batches of resin). Both methods focus on using minimal energy to complete the recycling process—something like using pure heat to melt a matrix away from a reinforcement is very energy intensive. Arkema targets making their Elium product 100% recycled; this requires current products to get recycled, which puts this goalpost out 20-30 years, based on Beneteau's estimated boat life span, and provides time to perfect the process (likely with assistance from the wind power industry).

In June 2022, Groupe Beneteau infused their first hull using this new recyclable resin, a First 44; it was launched in October. In 2023 they are aiming at industrializing this process; they molded two Classe Mini 6.5s in January, and the new Sun Fast 30 One Design, now being built, will be their first series-production sailboat in this recyclable resin.

Jacob asserts that the natural fibers they have tested aren't appropriate for higher stress areas like hulls, but small parts present a better opportunity. An entire Beneteau factory is dedicated to small parts, producing 30,000 parts per year (equivalent to 200 boats' worth of materials). Their aim is to use 20% hemp fibers, resulting in a net 11% drop in equivalent CO2 emissions for the factory. Flax, locally grown and a waste material from other industry, is also a material that is being integrated as possible (some applications in the Mini 6.5). They also dive into organics with their gelcoat; it contains 18% beetroots.

GreenBoats

GreenBoats, a German manufacturer, pushed into fully flax sailboat construc-

tion in 2015 when subcontracted to build the Green Bente 24. In 2019, they built their own Flax 27, designed by Judel/Vrolijk, by infusing low-viscosity bio-resins (notably, Sicomin's InfuGreen 810) into a 100% flax fiber reinforcement. Extensive testing ruled out a 100% bio-based resin for now, due to lack of durability in the marine environment, but they note the market is developing quickly.

Flax does not carry the same strength as fiberglass—it's about a third of the tensile strength, and about half as dense. However, flax does carry a higher specific modulus (that's the stiffness of the material adjusted for density). GreenBoats found a way to make their flax boat lighter than the fiberglass counterpart. Often overlooked on fiberglass production builds, they further optimized the structure through precision engineering and maintaining a higher level of craftsmanship. An open layup will let the flax swell and consume unnecessary resin, while vacuum bagging or press consolidation, used by GreenBoats and other builders, minimizes that unproductive addition of resin.

GreenBoats is now focusing on building the MB9, a 30-foot cruiser/racer, using the same construction techniques, while also supporting flax components for IMOCA 60s. They also offer a range of prefabricated flax composite panels, decreasing the research and development costs for other builders.

ABOUT THOSE BATTERIES

Builders speak about electrifying a sailboat's propulsion system to meet their environmental initiatives. To accomplish that, we need a renewable high-density energy storage method. With options limited, we turn to batteries. But, how are we sustainably developing the batteries to support those systems?

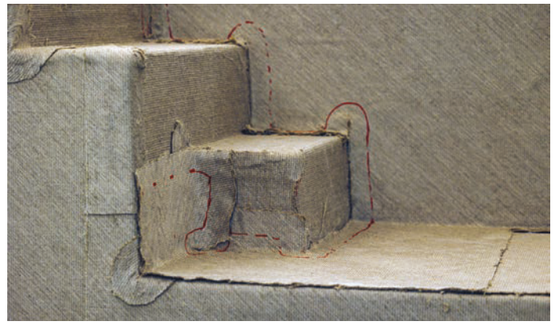
"[Our] engineering team determines how to maximize energy density without using conflict minerals or those that cannot be sustainably sourced," says Andrew Jay, CEO of Dakota Lithium. "There is a tradeoff, our batteries are heavier than, say the battery in your phone, or in an electric airplane, but the energy density by volume is comparable." He adds that their "batteries do not contain nickel, cobalt, magnesium (NCM), aluminum, or other common battery minerals. Dakota Lithium engineers exclusively use lithium, iron, phosphate chemistries (LiFePO4)."

Jay pushes his battery cell suppliers to use metallic lithium from Australia where labor practices and environmental impact can be monitored and measured. There are only three main sources of lithium— Australia, Chile, and China—and the supply chain is admittedly challenging to verify. A barrel of lithium carbonate cannot easily be tested to determine the origin. To change this, Jay supports a certification process at the commodity level, to ensure sustainable practices across the industry.

Compared to lead-acid batteries, well-engineered LiFEPO4 batteries offer five to seven times longer lifespan, higher discharge rates, and more efficient charging. As sailors, we also appreciate that LiFePO4 batteries do not contain an oxide. So, the battery is safer and unable to feed a fire, unlike these other NCM lithium technologies.

When a LiFePO4 battery reaches end of life, it is common that a single cell, or just the battery management system (BMS) has failed. Dakota Lithium designs their batteries for disassembly and reassembly. This means that most of the battery is still usable and can be reassembled into a reconditioned battery that is sold discounted on a secondary market. They have partnered with a third-party organization this year to accomplish exactly that. What happens after that? With lithium energy storage demand increasing, sustainably focused end-of-life recycling methods are under development.

PHOTO COURTESY OF WINDELO CATAMARANS



PHOTOS BY @ROBIN CHRISTOL, COURTESY OF OUTREMER CATAMARANS

Windelo Catamarans uses basalt fibers and recycled PET (used to make plastic bottles) in the Windelo 54, left. At Outremer Catamarans, flax fibers are used in some elements of construction, above; last year, Roland Jourdain was first to finish the Route du Rhum in the Outremer 5X We Explore*, made of 50% flax fibers.*

East Passage Boatwrights

Nature-driven composites are not new. In fact, wood is the original composite material, growing with cellulose fibers serving as the reinforcement and lignin creating the matrix. Our favorite marine woods even carry special extractives (organic impurities) that provide rot resistance.

East Passage Boatwrights in Bristol, Rhode Island, is experiencing how history can come full circle. Carter Richardson, founder and president, enjoys how traditional methods, when used conscientiously, are emerging as a more sustainable boatbuilding process.

Richardson's keel timbers are fabricated from white oak, sourced locally and sustainably by harvesting trees intermittently, not clear cutting. Planned appropriately, sustainable harvesting can be integrated into boat restorations. For example, in 2016, East Passage restored the 1935 yacht *Santana*. That allowed 81 years to plant new trees to grow into future beams, frames, and planks.

Richardson notes the naval shipbuilding forests: Forêt de Bercé in France, Sweden's oak forest on Visingsö, the U.K.'s Trafalgar Oaks, and the U.S. Naval Live Oaks Reservation in Florida. These were intended to supply nations with oak to build their naval fleets, with new trees planted to replace those harvested. Though made obsolete by steel shipbuilding, these forests still serve as sustainable forestry models and are used today to supply approved recreational boatbuilders with old-growth timber.

In yet another approach for sourcing lumber, East Passage Boatwrights obtains cedar planking from storm-felled trees in the marshes and swamps of Florida and Alabama. Given the hardiness of this wood, it remains unharmed after being submerged for extended periods before being harvested.

Teak is admittedly tough for a sustainability focus, and Richardson steers customers to alternatives in tropical hardwoods. Due to the steeply rising cost, associated tight supply, and more sustainable practices, he estimates that teak will no longer be an option for boatbuilding in the next two to three years. Mahogany is likely the next species to be phased out, but the FSC still stamps some of this wood.

The building process of plank-on-frame vessels is not as energy intense as fiberglass construction. A wooden-boat shop is often just above freezing in any higher-latitude winters, as dry, hot air is the enemy of wooden boats, causing them to shrink. This minimizes the impact of heavily climate controlling a shop. While East Passage Boatwrights use some epoxies and sealants, use is minimal, and this can be done as the weather cooperates.

Many sailors believe that wooden boats leak and require extensive yearly maintenance, but the popularity of wooden boats is on the rise. Adding a small amount of modern technology and thoughtful design, East Passage Boatwrights asserts that wooden boats can be dry and reasonable in maintenance, turning a stubborn opinion on its head.

Spirit Yachts

Spirit Yachts, on the other side of the pond, is also pursuing the fine art of the more sustainably built modern wooden yacht. Their plank-on-frame and cold-molded construction techniques negate the need for a hull or deck mold, eliminating waste and carbon emissions of that additional construction step. Like East Passage Boatwrights, Spirit Yachts sources their timber from responsibly managed forests and can verify exactly where the timber originates.

Using their in-house machine shop, Spirit Yachts has leveraged technology to eliminate waste. Nested cuts that were never possible by hand can be handled by machine with precision. Off-cuts are carefully repurposed in other areas of the build, and anything too small is donated to a nearby college. These decisions equated to a 20% reduction in waste materials on their Spirit 30.

To improve durability, Spirit bonds an outer skin of flax (rather than the more traditional fiberglass) to the hull of their Spirit 30, using a bio-based resin formulated by PRO-SET. Spirit Yachts remains focused on extending this technology to other builds. At the end of this boat's life, it can be stripped of its components, including the outer skin, and the timber can be reused or recycled. The strongback used for any build is disassembled and repurposed.

Spirit Yachts is currently building near 60% electric-drive or hybrid yachts, with the goal of hitting the 75% mark within the next three years. The Spirit 44CR encompasses this vision, being fully electric with no backup generator. Power is regenerated from the propeller while sailing and by solar panels integrated into the aft deck and mainsail.

> Our choices in how we use our boats can also drive change.

Final Thoughts

So, where does that leave us? We have traditional wooden boatbuilding techniques that can be low impact but are more expensive, and advanced composite approaches that are better adapted to production building but draw more on the environment. In all cases, how we use our boats has a bearing, advocating for lightweight and performance-oriented sailboats to minimize motoring.

This is a complex issue. Yacht design and construction has always carried inherent compromises, and adding the responsibility of decreasing our boats' life cycle impact only adds to a long list of trade-offs. Most boatbuilders aim to strike a balance; somewhere between form, function, performance, sustainability, and cost, they create what they believe is the ideal sailboat.

Our choices in how we use our boats can also drive change. While few have the patience to go engineless, can we be comfortable with a shorter powering range and go electric? What level of performance do we demand to enjoy sailing? How much boat do we need to be comfortable?

With boatbuilders taking different approaches to solving a similar issue, there is no consensus. We still don't have a proven solution for composite hull end-of-life, though we do appear to be moving closer to viable options. Extending the life of older boats and refitting them with electric propulsion shouldn't be snubbed, but there is also a natural drive for progress that pushes us to dream and create new vessels.

The leading builders are placing a primary environmental focus on cleaning up their shops and building boats that are cleaner to use. Material technology is changing, and many are keeping a weather eye in that direction. Everything comes at a cost, but how do we minimize that? Sailboats will likely never be built to have zero impact, but many boats are being built more sustainably today than they were yesterday. And that progress is encouraging.