SHIP RECYCLING IN A NUTSHELL

Date: 14.06.2024

GSR SERVICES GMBH
Auf dem Brink 1
21394 Südergellersen

Website: www.gsr-services.com
Email: info@gsr-services.com

LinkedIn YouTube

Table of Content

1. Introduction to ship recycling

Every ship has a lifespan, and when it reaches the end, what happens next is crucial. Ship recycling is a vital method that involves taking apart ships that are no longer in service to recover valuable materials such as equipment, steel, copper, bronzes, and various loose items. These materials are then sold in various markets. This process not only saves resources but also minimizes wastes and environmental impacts. By reusing materials, ship recycling reduces the need for new raw materials and promotes resource efficiency. It starts with safely breaking down the ship's structure, disposing of the hazardous materials, and sorting the tradable materials for direct reuse or repurposing into new products. It is common that more than 95% of a ship is reused or recycled, often even more.

1.1. Overview of the industry

The ship recycling industry is dynamic, involving demolishing of the ship's structure, disposing of hazardous substances, and recovering the steel and other useful equipment and materials. Ship recycling is essential for the maritime industry, contributing to significant environmental and economic benefits. While sub-standards facilities can still be found, many in this industry have changed tremendously or are in a transition. Implementing sustainable practices is crucial for ensuring that the end of a ship's life leads to new opportunities for resource conservation, positively contributing to sustainability and economic growth.

1.2. Methods

There are several methods of ship recycling, each having advantages and disadvantages:

- **Beaching/Landing**: Ships are grounded (beached), most often under own power, for being recycled while being grounded in a facility located directly at the shoreline. . An advantage is the ability to handle large vessels. However, these methods pose significant risks, such as limited accessibility to the ship itself and pollution of coastal areas by falling slag and paint chips as well as in case of leakages.
- **Afloat**: Ships are being taken apart while afloat and moored along wharfs, jetties or quays. Steel blocks and other equipment is cut in afloat condition and moved to a secondary cutting area on land by using cranes. This method can be challenging due to limited accessibility and risk of leakages as like beaching/landing plus maintaining the required stability of the ship for preventing capsizing.
- **Slipway**: Ships are winched onto a slipway for dismantling. It is also often used in combination with the afloat method where the remains of a widely dismantled ship is finally processed. This method has advantages in regards to leakage control, especially when the slipway has an efficient drainage system, and allows to work from all sides of the ship. It requires more lifting and careful handling of heavy blocks and equipment for preventing damages.
- **Dry Dock**: Ships are being demolished in a dry dock which accommodates entire ships on an impermeable floor structure. This method offers better environmental control, more options for access but requires more lifting, has limitations for evacuation in case of emergencies and is generally more expensive due to initial investment and required maintenance of the drydock itself.

1.3. Destinations

India, Bangladesh, Pakistan, and Turkey are major hubs that handle a significant portion of the world's ship recycling activities. Other destinations include Belgium, Norway, Denmark, Netherlands, UK, Canada and USA, which are generally associated with advanced environmentally sound recycling practices. However, it is always required to evaluate individual facilities as not all companies in one destination are operating with identical standards. Any regulation is only as good as the control and enforcement is.

1.4. Role of health, safety, and environment (HSE)

The ship recycling industry, while generating opportunities for massive employment, social uplift, reusing equipment / machinery, and substantial contribution especially to the developing countries' economies, also has inherent safety and environmental problems. Health, safety, and environment (HSE) are vital in ship recycling, which is considered as one of the most dangerous jobs in the world. Improper management of manifold risks or handling of hazardous materials like asbestos and heavy metals can pose significant consequences for workers and the environment.

Ship recycling today heavily depends on labor-intensive methods with considerable safety and health risks like direct injuries and long-term health effects. Workers can be exposed to toxic fumes while cutting metal coated with paint, leading to potential occupational diseases. Fire and explosions as well as falling objects or falling from height are also common risks.

The environmental impact of traditional ship recycling methods is significant. These methods often release toxic fumes, as well as slag and paint chips which fall into the water and harm marine life, deteriorate water and soil quality which also negatively affects the food chain.

As a consequence, cutting methods, such as using gas cutting, must be carefully operated and supervised to avoid negative effects of long-time exposure and environmental harm.

Additionally, many different operational aspects are to be considered like detection of hazardous materials, decontamination of oily blocks in combination with safe for entry and safe for hot work certification prior to hot work for ensuring a safe working environment and preventing pollution. High HSE standards ensure worker safety, prevent contamination and promote sustainable practices. It´s obvious that individual awareness and practices of a ship recycling facility is core factor and the ship recycling method itself plays a secondary role.

1.5. Sustainability

Ship recycling can support sustainability goals globally and on national levels. It reduces the need for new materials, lowers greenhouse gas emissions, and creates economic opportunities. Recycled steel from ships is vital for infrastructure projects and manufacturing and will play an even merrier role in transition to green steel. Removing materials for reuse and recycling contributes to the circular economy, especially when also social aspects are added.

1.6. Regulations

In a year from now, it is paramount for the ship recycling industry to comply with the Hong Kong international convention for the Safe and Environmentally Sound Recycling of Ships (HKC) of the International Maritime Organization (IMO). This convention sets comprehensive standards and provides guidance for ships and ship recyclers. Al major ship recycling hubs have ratified it and need to comply soon. In addition, the EU Ship Recycling Regulation (EU SRR), which has entered into force in 2013 already and became fully effective end of 2020, further mandates that ships flying the flag of an EU member state must be recycled in EU-approved facilities that meet higher environmental and safety standards. These regulations aim to protect workers and the environment while promoting sustainable ship recycling practices. A very similar regulation coming into effect together with HKC is the UAE-SRR which only accepts dry-docks (or similar) for recycling of ships within UAE and requires all ships in UAE-waters to have an IHM covering all substances as like under EU-SRR for EU-flagged vessels.

2. Why ship recycling?

2.1. End-of-life ships

It´s a matter of time when (nearly) anything becomes waste. Determining the end-of-life for ships is often a quite individual decision which involves a combination of visible factors and insights. The key indicators include but are not limited to:

- **Increased maintenance and repair costs**: when ships get older, they require more frequent and costly repairs, making continued operation economically unfeasible.
- **New requirements**: sometimes new requirements like for reduction of emissions or ballast water treatment etc. make it impossible or non-lucrative to modernize existing ships and drive them towards recycling.
- **Reduced operational efficiency**: older ships often suffer from decreased fuel efficiency and performance, leading to higher operational costs.
- **Market conditions**: fluctuations in market demand for shipping services, steel prices, and regulatory changes can influence the decision to recycle a vessel. Furthermore, low freight rates can reduce the profitability of operating older ships, making recycling a more attractive option.
- **Wars and geopolitical instability**: conflicts and geopolitical tensions can disrupt shipping routes and markets, prompting ship owners to recycle vessels earlier or even later than planned.

2.2. Economic considerations

Economic considerations involve evaluating the cost of maintaining an aging vessel versus the potential revenue from selling it for recycling. Commercially, selling a ship for recycling means to remove capacity from the market and prevent to potentially compete with it if it keeps trading for a new owner. Selling ships for recycling does not only generate direct income for ship owners and operators but also often leads to more cost-effective operations when old units are replaced by more efficient vessels.

Ship recycling is a recovery of materials which can be sold and reused, providing a valuable source of revenue. This also creates jobs in recycling yards and many other, not only steel-depended, industries.

2.3. Environmental benefits

Recycling of a vessel usually significantly reduces environmental impacts as old and less performing units stop trading. By repurposing steel and other materials, the need for mining and transport of new raw materials is decreased, conserving natural resources. Also, it prevents that old ships are abandoned or sunk, which causes severe marine pollution. In addition, further processing of scrap steel saves a lot of energy and depending on the energy source, also emissions (see below chapter on “Green Steel”). Recycling of old ships can prevent pollution and contribute to resource conservation, when being aligned with sustainable practices it reduces the ecological footprint of shipping to a great extent.

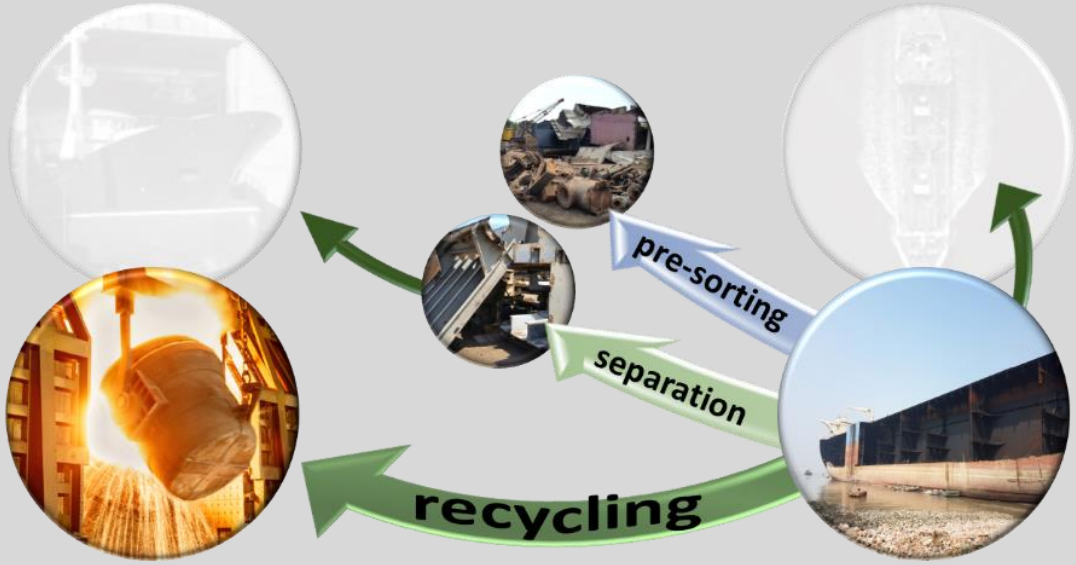
3. Steel recycling

3.1. Turning ships into scrap steel

The journey of recycled steel begins with its recovery from decommissioned ships. Skilled labor, proper planning and inspections to safely disassemble ships are essential.

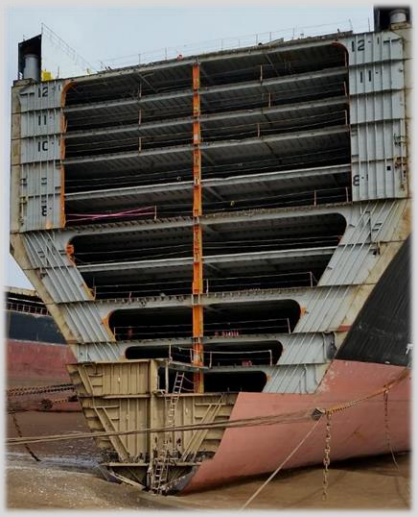
While quite a few components and materials can be segregated and traded further, or are to be disposed of, the steel-related processing is done in the following stages:

- **Dismantling**: the ship is systematically taken apart, separating steel from other materials such as components, machinery, non-ferrous materials etc., of which many can be traded further or have to be disposed of. In general valuables are separated from hazardous and non-hazardous wastes before or in parallel to cutting operations.
- **Primary Cutting**: the intact vessel is cut into large blocks. This initial cutting phase involves either lifting by heavy cranes or letting blocks fall, which is critical due to various risks and impacts.
- **Secondary Cutting**: large blocks from the primary cutting stage are further cut into smaller, more manageable blocks. This happens mostly in so called secondary cutting areas. Contaminated blocks need to be handled with special precautions like decontamination in-situ or on a separate impermeable floor prior to secondary cutting.
- **Tertiary Cutting**: if scrap steel is not sold in form of small blocks, then such blocks are cut into plates and profiles in a third cutting stage.
- **Stacking**: finally, the sheets and profiles, or small blocks, are shifted to a stacking area, where they are stored for further trade.



3.2. Pathways of scrap steel

Once the steel has been recovered and processed, it can follow several pathways as per demands in the hinterland of ship recycling facilities:



- **Reuse**: in some instances, straight steel plates and profiles are directly reused without further treatment. Such materials are often cut into the required dimensions and is directly re-used. This practice reduces emissions, energy consumption and processing costs most.

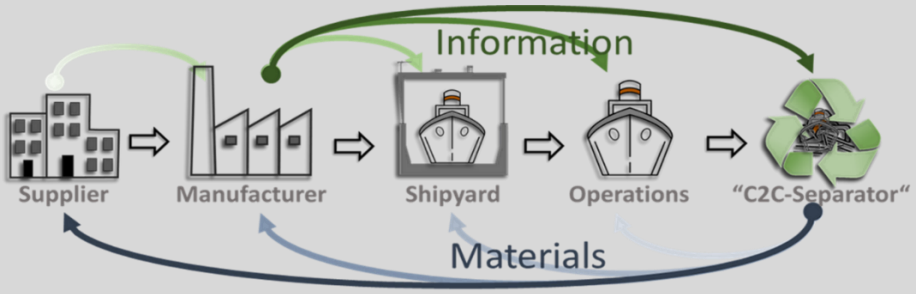
- **Re-rolling mills**: the recovered steel is re-rolled with minimal consumption of resources into new products such as bars, rods, or sheets. These products can then be used for various applications.

- **Manufacturing**: recycled steel is remelted and utilized to produce new products for many industries ranging from automotive parts and appliances to machinery, tools, and construction, including ships.

3.3. Benefits of steel recycling

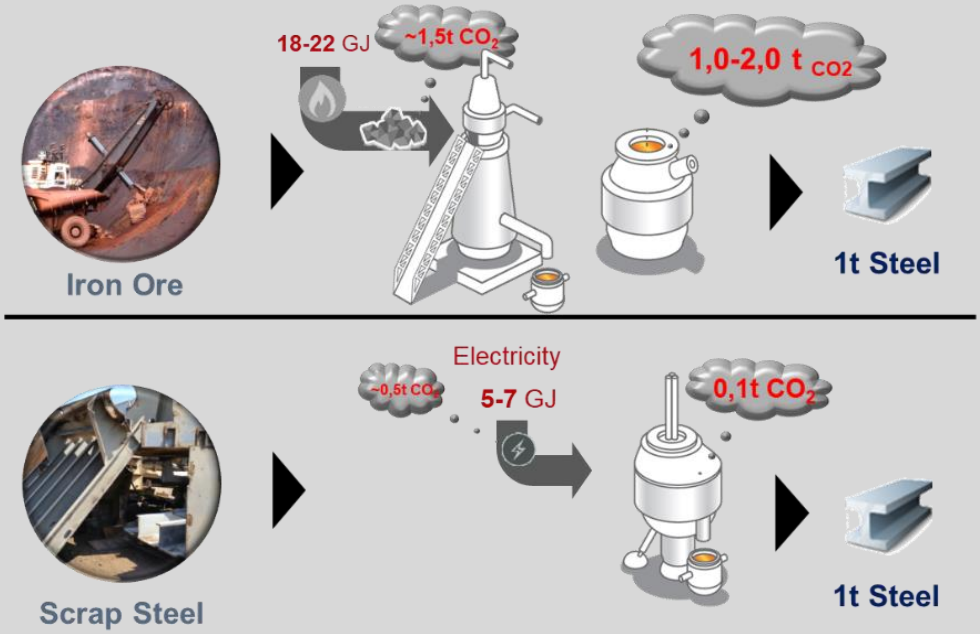
Ships contain vast quantities of various types of steel and its recovery plays a vital role in a circular economy by repurposing valuable materials. A crucial aspect is data on the materials used for a ship to avoid downcycling and loss of value. In case information can´t be gathered and compiled during the construction and maintained throughout the operational phase, there are options to identify them during a special inspection. Todays´ practice most often doesn´t segregate different steel grades which could further drive the already existing advantages:

- **Resource conservation**: reusing and recycling of steel reduces the demand for excavating and transporting new raw materials, conserving natural resources and lowering the environmental impact of mining and transportation from mining to the steel factory.
- **Energy savings**: recycling steel requires significantly less energy than producing new steel from iron ore, leading to considerable energy savings.
- **Reduced greenhouse gas emissions**: Recycling of recovered steel from ships significantly lowers energy demand and greenhouse gas emissions compared to the production of new steel from raw materials. This saving in energy use alongside the resource conservation explained, translates to lower carbon emissions, helping to reduce the overall environmental impact of steel during its life cycle and combatting climate change.
- **Cost efficiency**: Using recycled steel can lower material costs for building projects and industrial production, making it an economically attractive option for businesses aiming to reduce expenses and increase profitability.
- **Sustainable development**: by utilizing recycled steel in new products industries promote sustainable development, reduce costs and their environmental footprint. This supports a resilient circular economy (Cradle2Cradle, C2C) when a more segregated approach is applied right from the birth of products / ships.



4. Green steel

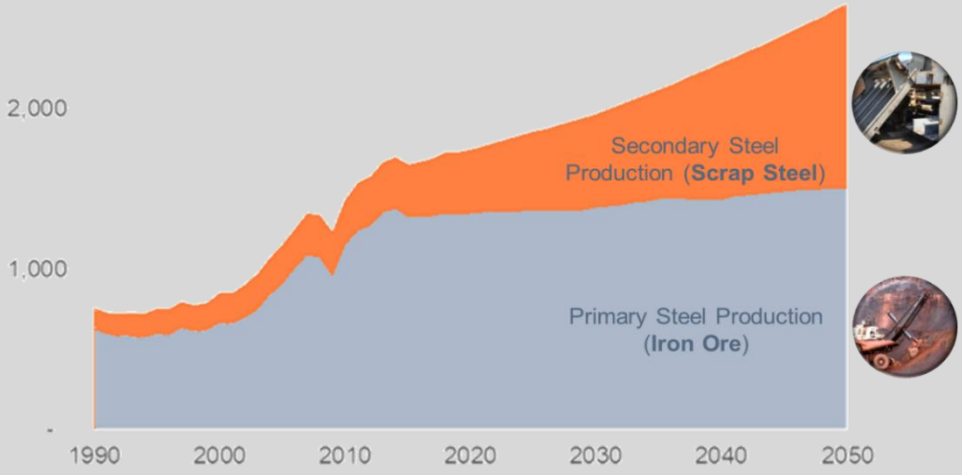
Green steel refers to steel produced with minimal environmental impact. This can be accomplished by utilizing renewable energy sources and adopting sustainable practices before and throughout production process (in the factories). The importance of green steel lies in its potential to considerably reduce carbon emissions and environmental impact, contributing to global efforts to combat climate change and promote sustainability. Green steel is the sustainable alternative to iron ore-based new steel combined with the use of renewable energy during its production process. The overview below provides a comparison of energy demands and production of CO_2 emissions between methods based on iron-ore and primarily scrap steel (like from ships).



Source: slide 10, presentation "Material Circularity in Shipping" by Henning Gramann, at 11th ACI Ship Recycling Congress, 7th-8th Feb. 2024, Athens- Greece

In some regions the steel industry wants to become carbon-neutral by 2050 which requires a shift from Blast Furnaces to Electric Arc Furnace (EAF) or Direct Reduced Iron (DRI). These production processes require more scrap steel with a higher purity then what is often provided by ship recyclers today. This can be achieved by proper identification and segregation of steel grades inherited in ships´ structures during the ship recycling process.

The performance of modern ship recycling facilities is essential for advancing green steel production and promoting sustainable practices. Ship recycling has the capacity to support the transition to a more sustainable steel industry.



Source: slide 11, presentation "Material Circularity in Shipping" by Henning Gramann, at 11th ACI Ship Recycling Congress, 7th-8th Feb. 2024, Athens- Greece

An effect of increasing scrap steel demand is that trading patterns for scrap steel will be highly affected and current net-exporters may become net-importers in a few years. Due to the growing demands for scrap steel and green steel as a product in light of responsible practices, scrap steel prices will be affected as well.

Green steel provides numerous benefits for local economies:

- **Job creation**: green steel facilities create jobs in manufacturing, engineering, and renewable energy sectors. This boosts local employment and supports sustainable economic growth.[1&2]
- **Local production**: producing green steel locally reduces dependence on imported materials, supports local industries, and enhances economic advantages. This can lead to a more resilient community, economy and a stronger industrial base.

4.1. Role of ship recycling for green steel

Modern and fully compliant ship recycling facilities are crucial for providing scrap steel for production of green steel. These facilities should be equipped with advanced technologies that improve efficiency, increase safety, and minimize the environmental impact. Key features of modern recycling facilities include but are not limited to:

- **Pollution control**: incorporation of systems to capture and treat emissions, reducing the environmental footprint of recycling operations.
- **Social safety**: besides operational aspects fair working conditions including social caretaking for workers, right of bargaining etc. are to be considered under sustainability aspects. The "Roundtable on Responsible Recycling of Metals" (RRRM) has recently published recommendations for corporate due diligence policies and voluntary sustainability standards concerning sourcing of scrap steel from ship recycling.
- **Energy efficiency**: utilization of renewable energy sources, such as solar and / or wind power, to operate the required machinery and infrastructure. In other words, produce fewer emissions, contributing to lower greenhouse gas emissions.
- **Advanced technologies**: implementation of state-of-the-art equipment for cutting and sorting, which enhances health, safety and environmental protection plus the quality of the recycled steel. This has also potential to save time and reduce emissions.
- **Material purity**: scrap steel and other materials including wastes are to be segregated thoroughly for ensuring purity of such different materials for making subsequent processing more efficient. It also prevents down cycling of valuable materials and promotes material circularity.

4.2. Suitable ship recycling facilities

State-of-the-art ship recycling facilities are not only having an efficient management setup but are also equipped with advanced technologies for ensuring that efficient and safe operations are achieved with minimized environmental impacts and meeting expectations of their business partners. This includes considering advanced cutting and cleaning tools and methods, as well as other segregation practices and systems that enhance operations and safety. This also includes contracting advanced companies for advanced handling of hazardous materials from safe removal from ships via treatment till disposals. Additionally, modern monitoring systems for the processes and ensuring compliance with safety

[1] https://climate.ec.europa.eu/news-your-voice/news/hybrit-story-unlocking-secret-green-steel-production-2023-06-20_en
[2] https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021-06_IND_INT_GlobalSteel/A-EW_236_Global-Steel-at-a-Crossroads_WEB.pdf

and environmental standards including employment of pollution control technologies for minimizing emissions and preventing contamination of air, soil and water.

Properly developed ship recycling facilities adhere to stringent environmental and safety standards to protect workers, surrounding communities and the environment. These standards are required by international regulations such as the Hong Kong Convention, EU Ship Recycling Regulation and International Labor Convention etc. All require comprehensive safety protocols, trainings, and procedures to prevent accidents and adverse effects like exposure to hazardous conditions.

Additionally, facilities must stay updated with industry trends and technological advancements to continuously improve their operations and meet the growing demand for sustainable recycling practices by up- and downstream trading partners.

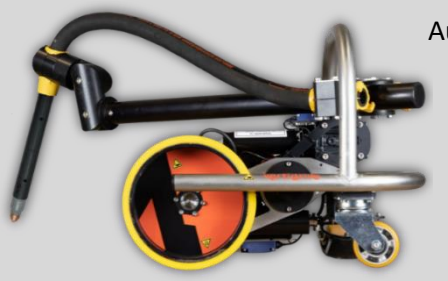
4.3. Technology and innovation

Technology and innovation play an essential role in enhancing ship recycling practices. The integration of cutting-edge technologies enables more efficient, safe, and environmentally friendly operations. Innovations in automation, robotics, and digitalization can revolutionized the industry, allowing for safer and more controlled recycling processes. These advancements help in effectively managing hazardous materials, reduce health and safety risks, and ensuring compliance with stringent environmental regulations. Innovation is not only required in regards to cutting, but also accommodating further demands towards material circularity. As such the ship recycling process, especially material identification and segregation, will become more complex and detailed. Automation can streamline processes and reduce the need for human intervention in hazardous tasks. As ships which have a digital twin will take decades to arrive at ship recycling yards, it is important to find suitable approaches in nearer future. Key technologies include 3D-scanning, material detectors, and specific inspection strategies for efficiently developing Material Inventories, which has to integrate findings as per Inventory of Hazardous Materials (IHM), which is more or less established already.

Robotic and remotely controlled crawlers, which move on the ship’s surfaces, can perform tasks such as cutting, cleaning, and inspection. These devices significantly enhance safety and efficiency, particularly in hard-to-reach and elevated areas. Plasma cutters, gas torches, and water jet nozzles can be easily integrated as like detectors into these crawlers, allowing for versatile and precise investigation, planning and operations.

4.4. Enhancing environmental protection, safety and efficiency

The cutting direction plays a crucial role in environmental impact and worker safety. Today methods often use oxy-fuel torches to cut the ship's hull from inside to outside, releasing slag and paint chips into the water and harming marine life. Cutting from outside to inside significantly reduces environmental impact, as debris falls inside the vessel instead of into the water. Cutting crawlers and manipulators for guided cutting devices allow to change the cutting direction from outside to inside the hull and superstructure. This alone substantially reduces environmental impacts caused by falling slag and paint chips when recycling is done on or above sand or water.



Automation enhances safety by minimizing number of workers working in, and potentially exposed to, risky and hazardous conditions. Automated systems provide consistent and effective operational results in tasks such as cutting and cleaning. By incorporating these advanced technologies, ship recycling facilities can achieve higher standards of safety and efficiency, minimizing risks to workers and reducing environmental impact.

By combining these and other advanced technologies, ship recycling facilities can achieve higher environmental performance and combine this with increased production efficiency.

5. Outlook

5.1. Demand for ship recycling

The ship recycling industry is expected to grow significantly in the coming years. BIMCO anticipates a surge in ship recycling activity over the next decade, forecasting more than 15.000 ships to be due for recycling. This is double the number of ships being demolished compared to the previous decade. This boom is driven by a combination of factors, including the more or less constantly growing world fleet, aging of the many vessels built in the 2000s and an increase in new ship orders and deliveries driven by substantial fleet renewal efforts, which is also related to emission reduction targets of IMO.

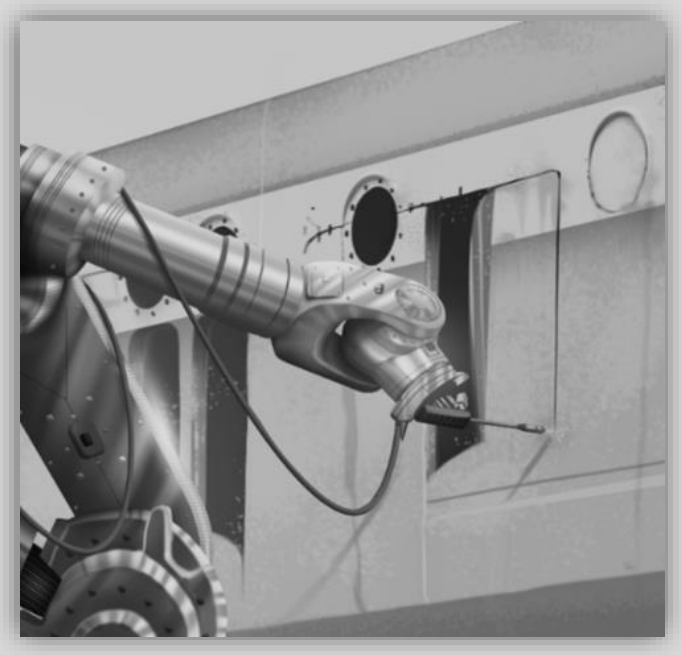
2005 2010 2015 2020 2025 2030 2035

5.2. New technologies

Integrating new technologies is essential for meeting future demands in ship recycling. Advanced technologies such as advanced cutting systems, automated tank cleaning, robotic crawlers, and advanced monitoring tools will enhance operational efficiency, safety, and environmental performance. Paying attention to investing in research and development is paramount. Facilities must also focus on training and upskilling their workforce to effectively use these new technologies, ensuring a smooth transition and maximizing the benefits of technological integration. Last but not least, accessibility of the facility itself as well as the ship under recycling in the view of safety, emergency preparedness and environmental protection are important aspects to be accommodated well. In regards to choosing the right technology mix it is important to note that the cost of producing a ton of ready-made material is more significant than cutting speed alone. It doesn't pay off to cut twice as fast if it triples the cost of a ton of ready-to-sell materials.

5.3. Increasing capacity

To meet the anticipated rise in ship recycling demand, new countries, especially those who either have ships for recycling or those importing scrap steel, must plan for increased capacity. This involves repurposing shipyards, expanding existing yards, developing new sites, parallelization of activities and investing in technologies & infrastructure. Key considerations include enhancing logistical capabilities, ensuring adequate space for handling larger numbers of bigger and bigger ships, enhancing the practices to meet the highest standard, and improving material flows internally as well as external waste management systems to cope with increased material flows. Effective methods and processes will enable facilities to handle the projected growth efficiently and sustainably and to be more lucrative.



In case of new locations, it is important to consider trading routes and local demands when developing the business plan. In some cases, identification and serving a very specific market and demand may be more lucrative then being one of many in a highly competitive market.

6. Conclusions

6.1. Importance of sustainable ship recycling

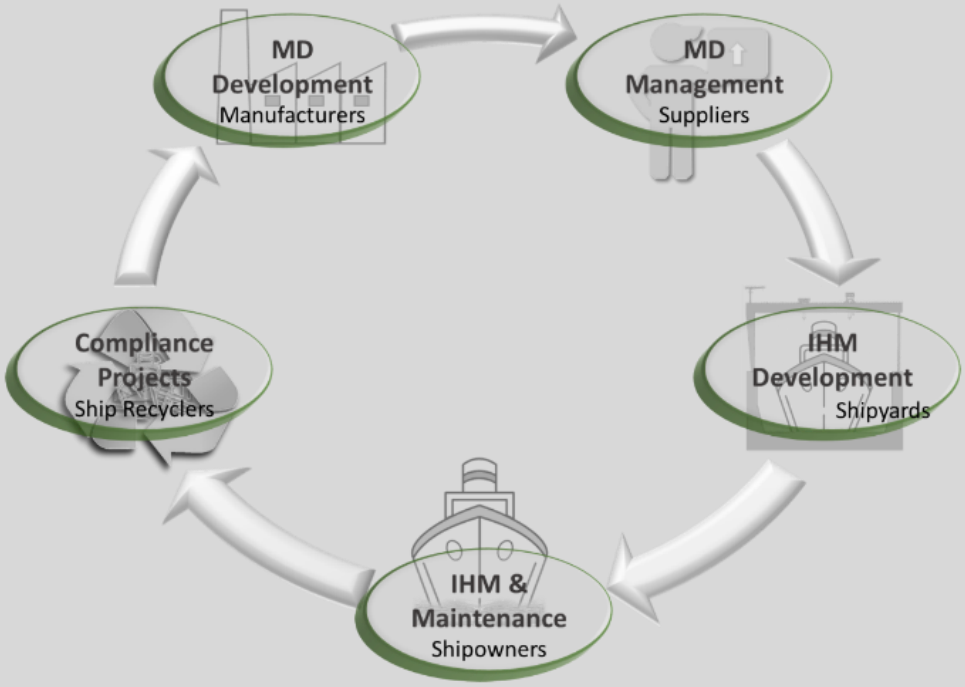
Sustainable ship recycling is crucial for environment, human health and economy. By recycling of ships at the end of their life cycles and repurposing their materials like steel, copper, aluminum, and other valuable metals and materials, we conserve natural resources, minimize waste, and reduce greenhouse gas emissions. A commitment to Health, Safety, and Environment (HSE) standards ensures that workers are protected and environmental impacts are mitigated. Compliance with international regulations such as the Hong Kong Convention and the EU Ship Recycling Regulation are paramount and establish these goals and should be understood as minimum requirements. The commonly applied methods and processes are to be reviewed in light of new approaches and priorities, this will lead to application of new technologies and supporting green steel which will not only help to reduce the environmental impact but also potentially inspire others to adopt similar practices.

6.2. Call to action for stakeholders

All stakeholders, governments, ship owners, recycling facilities, and industry organizations have to minimize their footprints and prioritize sustainable practices, which includes in ship recycling. Adhering to international standards, application of advanced methods and technologies means continual improvement of efficiencies. By working together, we can ensure that ship recycling not only meets current demands but also contributes to a greener, more sustainable, lucrative and circular future.

Sustainable ship recycling is essential for the future and sustainability of the maritime industry. By embracing best practices, investing in technology, and adhering to strict environmental and safety standards, we can create a thriving, sustainable ship recycling industry that benefits everyone.

GSR Services is committed to supporting new and upgradation in the ship recycling industry. Our expertise in upgrading recycling facilities, guidance for new projects, and developing innovative solutions with the right technology mix ensures that we provide valuable support to those seeking for adopting sustainable approaches. By fostering collaboration and innovation, we help the industry to meet future demands and achieve sustainability goals.



7. Expertise in ship recycling

At GSR Services, we are proud to support the ship recycling industry with our expertise, innovative solutions, and unwavering commitment to sustainability. Due to our active involvement from suppliers and manufacturers via shipyards and shipowners we also fully understand their expectations and integrate those into the planning of ship recycling.

Our commitment to sustainability means adhering to effective compliance, best practices, and maintaining economic competitiveness. We are dedicated to Quality, Health, Safety, and Environment (QHSE), ensuring that our projects not only meet but exceed industry standards.

GSR Services has gathered extensive experience since 2005 from development of international rules to supporting implementation. We have successfully worked with 50 recycling yards in India, Bangladesh, and Turkey to comply with the Hong Kong Convention (HKC), for some also to meet EU standards. Our approach is that each project is unique, requiring careful consideration of individual aspects to ensure the best outcomes.

Services offered to support ship recycling and green steel

- **Consultancy and advisory services**: we provide expert guidance on ship recycling projects, helping clients navigate regulatory requirements and optimize their operations.
- **Upgrading ship recycling facilities**: with our extensive experience, we can upgrade existing recycling facilities, including planning of infrastructure and systems. We also guide new projects on how to establish state-of-the-art recycling yards that adhere to sustainability and highest standards.
- **Research and Development projects**: we engage in R&D to develop new technologies and methods for sustainable ship recycling, green steel production and establishing Cradle2Cradle.
- **EU-Taxonomy / CSRD / ESG** Complex evaluation and reporting requirements are coming up which require thorough analyses of products, business interactions, risks, impacts and finally financing. We cooperate closely with stakeholders and take care of their duties by setting up efficient sustainability and reporting strategies.