REMEDIES: Co-Creating a Plastic Litter Free Future

DELIVERABLE: D3.3

TITLE: Zero-waste cosmetics

REVISION TABLE		
Document Version	Date	Modified sections - Details
V0.1	15.2.2025	Draft version sent to authors
V0.2	20.5.2025	Completed LCA evaluation
V0.4	1.10.2025	Finalizing surveys as co-creation process
V0.5	19.11.2025	Addition all the events
V0.8	9.1.2026	Quality check from NTUA
V.1	12.1.2026	Final version

Disclaimer

This project is Co-funded by the European Union - HORIZON EUROPE program, under grant agreement No. 101093964. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the Climate Infrastructure and Environment Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

Contractual Date of Delivery	14.2.2025
Actual Date of Delivery	31.12.2025
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WP contributing to the deliverable	WP3
Nature	PUB
Version	V.1

ABREVIATIONS AND ACRONYMS

NIC	National Institute of Chemistry
ANGR	Alchemia Nova Greece
EXIT	Exit fundation
EU	European Union
SDG	United nations sustainable development goals
FDA	Food and drug administration
ECSA	European Citizen Science Association

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LCA	Life cycle assessment
COSMOS	Standard for organic and natural cosmetics
GWP	Global warming potential
PET	Polyethylene terephthalate
HDPE	High-density polyethylene
PP	Polypropylene
GHGs	Greenhouse gases
TRL	Technological readiness level
SRL	Societal readiness level

EXECUTIVE SUMMARY

The EU-funded REMEDIES project (Grant agreement ID: 101093964) is a comprehensive initiative dedicated to the restoration of our seas and rivers by implementing innovative pathways for the detection & monitoring, collection & valorisation and prevention & zero-waste of (micro)plastic litter. With a strong focus on sustainability and environmental stewardship, the project aims to address the pressing issue of plastic pollution through a multifaceted approach that encompasses monitoring and detection, collection and valorisation, and prevention and reuse of plastic waste. At the core of the REMEDIES movement is the ambition to cultivate a plastic-conscious society by actively engaging citizens in the fight against plastic pollution with the special emphasis on oceans, seas and waters.

The deliverable 3.3 *"Zero-waste cosmetics"* is the outcome of Task 3.4. dealing with the demonstration and upscaling of the zero-waste cosmetics, and in particular, a seaweed coating solution as a viable alternative to shampoo single use plastic bottles, built on the demonstration of zero-waste cosmetics to the citizens addressed by one of the three REMEDIES pillars (Prevention & Zero-waste). Within this deliverable, a citizen engagement methodology was developed and implemented in co-creation workshops with various stakeholders. To reach the level of citizen science demonstrator a multiple stage of learning steps when interacting with citizens was done. Thus, to strengthen these interactions workshops and differentiate the stakeholders as well as consider gender dimension in testing and adjusting the citizen science approach, 19 different events were held by the NIC team, along with REMEDIES partners EXIT

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and ANGR, in order to receive feedback from the participants and end users on both the methodological approach towards more efficient demonstrations and absorbed know how by the participants as well as end user education on the zero-waste plastic free lifestyle.

The structure of D3.3 is divided into 7 chapters. It begins with an introduction to the zero-waste concept (Chapter 1) and builds on the know-how of cosmetics preparation and packaging (Chapter 2). It then covers the evaluation of the zero-waste seaweed coating innovation (Chapter 3), followed by the co-development and co-creation of citizen science demonstration protocols (Chapter 4), including the gender dimension, along with descriptions of citizen-related events and outputs (Chapter 5). Chapter 6 showcases the results of the citizen science activities, and Chapter 7 provides conclusions and future remarks.

Citizen science approach was preliminary used to develop the methodology for educational and business workshop incorporating stakeholders from school children to policy makers. As a results completion of three do-it-yourself guidelines in an open-source format, surveys to evaluate the educational/engagement and gender dimension and the communication material to zero-waste community, policymakers and businesses.

During the activities described in D3.3, in the period 2023-2025, building upon the citizen science demonstration approach, more than 500.000 people were reached through a combination of in-person events, TV shows and social media engagement. Altogether over 5.000 citizens made shampoo balls with seaweed zero-waste coating have been performed. The do-it-yourself guidelines and surveys were successfully shared with more than 150 citizens/businesses as a potential replication of our zero-waste citizen science demonstrators. All the co-created toolkits are available in open access as educational citizen engagement presentation. Additionally, a preliminary zero-waste seaweed coating process carbon footprint and cradle-to-gate environmental footprint was evaluated and optimization feedback loop using overall environmental cost-benefit analysis, considering midpoint environmental prices per impact category to optimize the step in the final do-it-yourself guidelines protocols.

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Chapter 1: Introduction to zero-waste concept

In this chapter, the readers will be introduced to the concept of zero waste, including its definition, usage and implications for EU policy and citizen engagement communications.

1.1. The mission of zero waste cosmetics

Planet Earth has always followed zero-waste principles. For millions of years, up until the industrial era, waste was not a developed concept because most discarded material from civilisations were used as inputs for other processes, retaining their value in a circular way, just like nature does. However, what nature has done through evolution, humankind needs to do by design today. On the other hand, we are entering a 'storm' of climate change and biological resource constraints. The earlier companies, cities, and countries plan ahead and prepare themselves for the predictable future, the better their chances of thriving. Each year, Earth Overshoot Day[1] marks the date when we have used all the biological resources that the Earth can renew during the entire year (Figure 1). To determine the date of Earth Overshoot Day, the Global Footprint Network[2], an award-winning international research and non-profit organization, combines data and makes the most reasonable assumptions to assess humanity's resource situation.

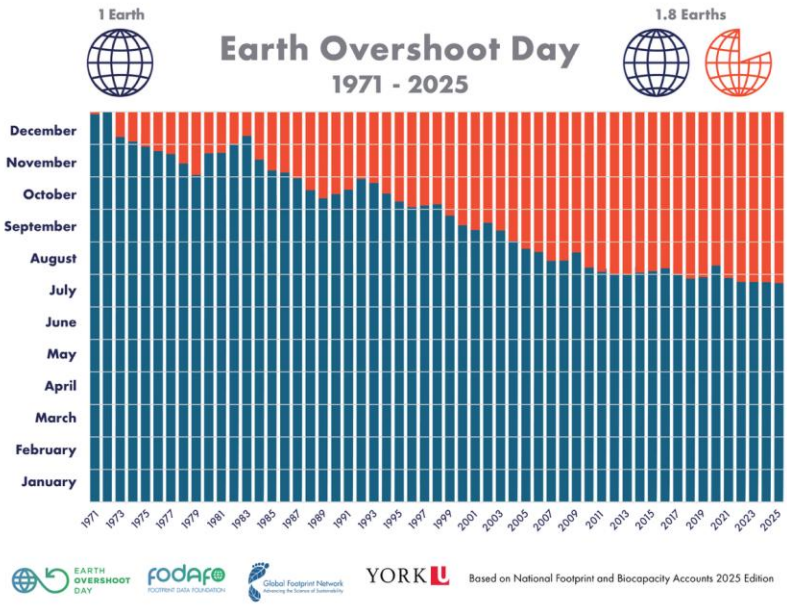

Figure 1: Earth overshoot day every year in the period of 1971-2025 (Source: online[3])

[1] https://www.overshootday.org/ (accessed 1.12.2025)
[2] https://www.footprintnetwork.org/ (accessed 1.12.2025)
[3] https://www.genevaenvironmentnetwork.org/resources/updates/earth-overshoot-day/ (accessed 1.12.2025)

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Systematically advance resilience and sustainability through thorough exploration of renewable biomass and waste streams, not only to replace current practices, but primarily to create new value-added products and energy. Embrace a zero-waste approach by closing loops, reducing material use and emissions, and protecting the environment and resources for future generations.

In this context, the evaluation of both the biological concepts presented in natural ecosystems and (bio)design-based approach can help reverse the trend of overconsumption of single-use items, which are unnecessary for most people's lives.

A dedicated case study on building circular (bio)economies examined the circular economy as a system in which materials do not become waste and nature is regenerated. Within this logic, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting. The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products for as long as possible, thereby extending product life cycles.. In practice, this means reducing waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible through recycling, allowing these products to be used productively again and again, thus creating further value. The circular economy is examined in terms of economic prosperity, along with environmental quality and its impact on social equity and future generations. Nonetheless, business models and consumers behaviour are identified as enablers of the circular economy. The circularity strategies begin with the 3Rs (Reduce-Reuse-Recycle), extend to the 4Rs (Reduce-Reuse-Recycle-Recover), progress to the 9Rs (Refuse-Rethink-Reduce-Reuse-Repair-Refurbish-Remanufacture-Repurpose-Recycle-Recover) and even the 12Rs (Refuse, Rethink, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, Research, Re-skill, Re-design, Re-vision and Recover). In many instances, an R - based approach is also used in connection with the zero-waste description, although this does not always align with zero-waste principles. Therefore, a holistic definition going beyond the Rs has been considered. For this and the case of zero-waste cosmetics the logic described next is followed.

1.1.1 Crafting the definition of zero waste

One of the most used definitions is from the Zero Waste International Alliance, which was updated and adopted by the ZWIA board December 2018. This restructuring aligns the definition with the guiding principles of the Zero Waste Hierarchy to create a globally accessible statement of meaning.[4]

»Zero waste is the conservation of all resources by means of responsible production, consumption, reuse and recovery of products, packaging and materials without burning, and with no discharges to land, water, or air that threaten the environment or human health«

One of the primary goals in organizing the Zero Waste International Alliance in 2002 was to establish standards to guide the development of Zero Waste worldwide. The Planning Group of the Zero Waste

[4] https://zwia.org/zero-waste-definition/ (accessed 1.12.2025)

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International Alliance adopted the first peer-reviewed internationally accepted definition on November 29, 2004. The revised definition adopted by the Zero Waste International Alliance on August 12, 2009, is provided below.

"Zero Waste is a goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use. Zero Waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them. Implementing Zero-Waste will eliminate all discharges to land, water or air that are a threat to planetary, human, animal or plant health."

Moving from these definitions in a holistic sense to practical implementations, most approaches follow previously established terminology aligned with the circular economy.

The evolution of the circular economy to zero-waste, which is used as a philosophy and set of principles aimed at minimizing waste generation and promoting the sustainable use of resources, is most typically presented as the zero-waste pyramid shown in Figure 2. The goal is to create a circular economy in which products are designed, used, and repurposed in a way that eliminates the concept of waste. Key principles of zero-waste include:

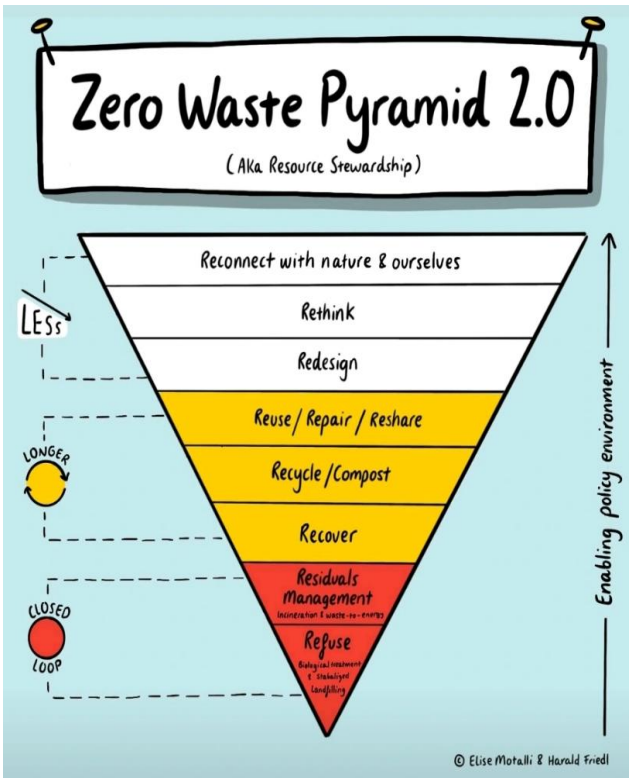

Figure 2: Typical presentation of zero-waste pyramid @Elise Motalli & Harald Friedl

Reducing consumption: Prioritizing the reduction of unnecessary purchases and avoiding single-use items.

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Reusing: Extending the life of products through repair, repurposing, or sharing.

Recycling: Ensuring materials are recycled properly to keep them in the production cycle.

Composting: Returning organic waste to the earth through composting or anaerobic digestion.

Redesign: Encouraging the design of products and systems that are durable, repairable, and recyclable.

The ultimate aim of zero-waste, in line with the circular economy, is to send nothing to landfills, incinerators, or the environment, and to shift toward a sustainable, closed-loop system. Zero-waste applies to individuals, businesses, communities, and governments.

These two approaches—to optimise and to influence, or to sell—converge in the zero-waste movement, which encompasses minimising the amount of waste we produce in general. Living a waste-free lifestyle is theoretically possible; in practice, it is easier said than done. More and more people are realising the effect their contributions to waste have on the environment.

The concept is based on five main principles, also referred to as the 5R's:

- Refuse: Consciously refuse waste, such as unnecessary packaging. More broadly, avoid what we consume in general. The less we consume (or refuse), the less is produced for disposal later.
- Reduce: Reduce what we consume and aim for a more minimalist lifestyle. How many pieces of clothing do we own that we have not worn in years? Resources were used to produce those items. Reducing what we own or do not require can make it easier to sell or donate items that may be useful to others.
- Reuse: In recent years, single-use products have surged. Such items benefit producers more than consumers, as they require continual repurchase. More and more throwaway products are produced than items are repaired.
- Recycle: Items left over after applying the first three principles should be recycled. This helps conserve resources.
- Rot (Composting): Compost what you don't consume to create high-quality manure for soil.

1.2. Zero-waste cosmetics - current state of mind

As businesses and individuals continually seek to reduce costs, optimize their daily operations, and adopt "smart" solutions, zero-waste is becoming a trend and creating buzz across Europe and beyond. Implementing a business idea often means working with people who are real system optimisers. They don't like waste because it indicates a system inefficiency. Waste not only costs businesses money, but it also reflects poor design. As circular thinking gains popularity, leaders around the world are recognising the strong alignment between the zero-waste philosophy and business performance.

Is following zero-waste really possible at home? It begins with purchasing decisions, proper planning, and setting up a system for what, and how, materials enter your home in the first place. There are many blogs, videos, and books published to help people transition towards a zero-waste lifestyle. Ultimately, it is mostly

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a matter of conscious shopping and proper waste separation at home; however, this level of engagement is often driven primarily by women[5].

Our cities and municipal waste management systems still have significant progress to make before zero-waste becomes mainstream, and our mission is to advance this discussion at the European level. Until then, there are many actions individuals can take to cut costs, live smarter, and reduce their environmental footprint.

Mainstream zero waste cosmetics are distinguished by certain criteria that make them particularly sustainable. For instance, regarding packaging, cosmetic brands aim to establish a recycling loop that truly qualifies a product as "Zero-Waste." This often involves refillable systems, where packaging is reused multiple times, eliminating the need for new resources since the existing packaging is simply refilled. Additionally, incorporating upcycled ingredients is a key aspect of zero-waste cosmetics. Upcycling transforms by-products or waste from production into new, valuable materials or products. Many natural cosmetic formulations include ingredients derived from upcycled sources, often originating from food processing waste. Examples include lemon or orange peels, tea or coffee grounds, and dried fruit seeds, all of which can be repurposed for use in natural cosmetic products. Although many brands have made significant progress, integrating their products into a closed-loop system is just the beginning. For zero waste cosmetics to drive real industry change, they need to become mainstream. Proper disposal of packaging by consumers is crucial to support circular business models, as the separation and recycling of materials are vital components of circular cosmetics. Consumers can contribute by choosing and correctly disposing of zero waste products, and every purchase of a sustainable cosmetic helps move the industry towards positive change. As the popularity of circular beauty grows, many brands are now adopting circular economy principles, especially in response to increasing consumer demand for clean, sustainable products. But what exactly does "circular cosmetic" mean? What role does it play in the beauty industry, and what criteria must a product meet to be considered circular? All these questions bring the consumer to the point when in order for a conscious decision to be made, both educational and experientially step can be beneficial.

1.3 Legislative push towards reducing plastic pollution within the EU and beyond

The EU aims to become a forerunner in the global fight against marine litter and plastic pollution. EU rules seek to reduce the volume and impact of certain plastic products on the environment.

Data published by Eurostat showed that the EU's 27 member states generated approximately 83.4 million tonnes of packaging made from paper and board, plastic, glass, wood, metal and other materials in 2022, the latest year for which statistics are available. This was 1.4 million tonnes less than in 2021. Per capita arisings also fell from 190.1 to 186.5 kilograms. In 2021, the recycling rate returned to an upward trend, reaching 39.7%.[6],[7]

[5] https://srip-krozno-gospodarstvo.si/wp-content/uploads/2022/01/Strokovno-gradivo.pdf (Accessed 29.12.2025)
[6] https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20231019-1 (accessed 1.12.2025)
[7] https://www.euwid-recycling.com/news/policy/eu-packaging-waste-recycling-rate-increases-amid-lower-arisings-290525/ (accessed 1.12.2025)

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Single-use plastic products (SUPs) are used once, or for a short period of time, before being discarded. The impacts of this plastic waste on the environment and human health are global and can be severe. Single-use plastic products are more likely to end up in the sea than reusable alternatives. The 10 most common single-use plastic items found on European beaches, alongside fishing gear, represent 70% of all marine litter in the EU[8].

The 10 items being addressed by the Directive are:

- Cotton bud sticks
- Cutlery, plates, straws and stirrers
- Balloons and sticks for balloons
- Food containers
- Cups for beverages
- Beverage containers
- Cigarette butts
- Plastic bags
- Packets and wrappers
- Wet wipes and sanitary items

1.3.1 Reduce packaging, restrict certain types and ban forever chemicals

The rules, which have been provisionally agreed on with the EU Council, set packaging reduction targets of (5 % by 2030, 10 % by 2035 and 15 % by 2040) and require EU countries to reduce the amount of plastic packaging waste in particular. To reduce unnecessary packaging, a maximum empty space ratio of 50 % is set for grouped, transport and e-commerce packaging. Manufacturers and importers will also have to ensure that the weight and volume of packaging are minimised. Certain single use plastic packaging types will be banned from 1 January 2030. These include packaging for unprocessed fresh fruit and vegetables, packaging for foods and beverages filled and consumed in cafés and restaurants, individual portions (for e.g. condiments, sauces, creamer, sugar), accommodation miniature packaging for toiletry products and very lightweight plastic carrier bags (below 15 microns). To prevent adverse health effects, further restrictions will ban the use of so-called "forever chemicals" (per- and polyfluorinated alkyl substances or PFASs) above certain thresholds in food contact packaging.[9]

[8] https://environment.ec.europa.eu/topics/plastics/single-use-plastics_en (accessed 1.12.2025)

[9] https://www.europarl.europa.eu/news/en/press-room/20240301IPR18595/deal-on-new-rules-for-more-sustainable-packaging-in-the-eu (accessed 1.12.2025)

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1.3.2 Encourage reuse and refill options for consumers

Specific 2030 reuse targets are foreseen for alcoholic and non-alcoholic beverages packaging (except e.g. milk, wine, aromatised wine, spirits), transport and sales packaging, as well as grouped packaging. Member states may grant a five-year derogation from these requirements under certain conditions.

Final distributors of beverages and take-away food will have to offer consumers the option to bring their own container. They will also be required to endeavour to offer 10 % of products in a reusable packaging format by 2030.

1.3.3 Recyclable packaging, improved waste collection and recycling

Under the new rules, all packaging (except for lightweight wood, cork, textile, rubber, ceramic, porcelain and wax) will have to be recyclable by fulfilling strict criteria.

The measures also include minimum recycled content targets for plastic packaging and minimum recycling targets by weight of packaging waste.

By 2029, 90% of single use plastic and metal beverage containers (up to three litres) will have to be collected separately, either through deposit-return systems or other solutions that ensure the collection target is achieved).

1.3.4 REACH directive for intentional additions of microplastics in cosmetics

To tackle microplastics[10] pollution while preventing the risk of market fragmentation, the Commission requested the European Chemicals Agency (ECHA) to assess the risk posed by microplastics intentionally added to products and whether further regulatory action at EU level was needed. ECHA concluded that microplastics intentionally added to certain products are released into the environment in an uncontrolled manner and recommended restricting them.

Based on the scientific evidence provided by ECHA, the Commission drafted a restriction proposal under REACH[11] that was positively voted by the EU countries and successfully passed the scrutiny of the European Parliament and the Council before being adopted.

[10] Microplastics are small plastic particles that are found in countless conventional cosmetic products such as scrubs and toothpaste, whereby many of these particles contain plasticisers and phthalates which can be hormonally active or even toxic. These tiny particles are set free in the environment via our drainage systems. Furthermore, environmental toxins accumulate on the surface of microplastics.

[11] https://eur-lex.europa.eu/eli/reg/2023/2055/oj (accessed 1.12.2025)

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The Commission is committed to fighting microplastics pollution, as stated in the European Green Deal[12] and the new Circular Economy Action Plan[13]. In the Zero Pollution Action Plan[14], the Commission set a target to reduce microplastics pollution by 30 % by 2030.

As part of these efforts, the Commission is working to reduce microplastics pollution from different sources: plastic waste and litter, accidental and unintentional releases (e.g. plastic pellet loss, tyre degradation or release from clothing), as well as intentional uses in products.

The European Commission has taken another major step to protect the environment by adopting measures that restrict microplastics intentionally added to products under the EU chemical legislation REACH. The new rules will prevent the release of about half a million tonnes of microplastics into the environment. They will prohibit the sale of microplastics as such, and of products to which microplastics have been intentionally added and that release those microplastics during use. When duly justified, derogations and transition periods for affected parties to adjust to the new rules will apply.

The adopted restriction uses a broad definition of microplastics - it covers all synthetic polymer particles below five millimetres that are organic, insoluble and resist degradation. The purpose is to reduce emissions of intentionally added microplastics from as many products as possible. Some examples of common products within the scope of the restriction are:

- Granular infill material used on artificial sports surfaces - the largest source of intentionally added microplastics in the environment.
- Cosmetics, where microplastics are used for multiple purposes, such as exfoliation (microbeads) or obtaining a specific texture, fragrance or colour.
- Detergents, fabric softeners, glitter, fertilizers, plant protection products, toys, medicines and medical devices, just to name a few.

Products used at industrial sites or not releasing microplastics during use are exempt from the sales ban, but their manufacturers will have to provide instructions on how to use and dispose of the product to prevent microplastics emissions.

1.4. Mission Restore our ocean and waters by 2030

REMEDIES project is part of the EU Missions are large-scale initiatives under Horizon Europe designed to tackle major global challenges, such as climate change, cancer, soil health, ocean restoration, and the development of climate-neutral and smart cities. They set clear, time-bound goals and bring together research, policy, and stakeholders to drive innovation and deliver concrete solutions for societal benefit. The Mission Restore our ocean and waters by 2030 (Figure 3) provides a systemic approach to the

[12] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en (accessed 1.12.2025)
[13] https://ec.europa.eu/commission/presscorner/detail/en/ip_20_420 (accessed 1.12.2025)
[14] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_2345 (accessed 1.12.2025)

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protection and restoration of the ocean and Europe's seas and waters by 2030, fostering a sustainable marine and freshwater environment. riven by research and innovation and aligning with the European Green Deal targets, the Mission is addressing three specific objectives with clear 2030 targets for: protecting and restoring marine and freshwater ecosystems and biodiversity; preventing and eliminating ocean, sea, and water pollution, and ensuring a sustainable, carbon-neutral, and circular blue economy.

Figure 3: Mission Restore our Ocean & Water visuals (Source: online)

The Mission supports the implementation of key EU policies and regulatory initiatives for the ocean, seas, and waters, including the EU Biodiversity Strategy and Nature Restoration Regulation, the EU Action Plan Towards Zero Pollution for Air, Water, and Soil, the European Climate Law, the European Water Resilience Strategy, and the European Ocean Pact. Additionally, it contributes to Europe's sustainable prosperity by driving both green and digital transitions across these vital ecosystems.

The Mission supports United nations Sustainable development goals[15] - SDG 14 by regenerating our oceans and waters and SDG 6 by ensuring the availability and sustainable management of water and sanitation for all, in addition to contributing to achieving most other SDGs, including climate action (SDG13) and the sustainability of cities and communities (SDG11).

Through research and innovation, public engagement, and targeted blue investments, this Mission takes a systemic approach to:

1. Protect and restore marine and freshwater ecosystems and biodiversity, in line with the EU Biodiversity Strategy 2030.

2. Prevent and eliminate pollution of our ocean, seas and waters, in line with the EU Action Plan Towards Zero Pollution for Air, Water and Soil.

3. Make the sustainable blue economy carbon-neutral and circular, in line with the proposed European Climate Law and the comprehensive vision outlined in the Sustainable Blue Economy Strategy.

[15] https://social.desa.un.org/2030agenda-sdgs (accessed 1.12.2025)

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REMEDIES as mission ocean Mediterranean Sea basin lighthouse project is focused on the 2nd point preventing the plastics and microplastics pollution in the Mediterranean, following these specific objectives.

- Reduced pollution from litter, plastics and microplastics in European rivers.
- Accelerated uptake of innovative solutions to prevent and minimize pollution of rivers by litter, plastics and microplastics.
- Effective monitoring of litter, plastics and microplastics in freshwaters to implement the Water Framework Directive and Marine Strategy Framework Directive.
- Reduction by at least 50% plastic litter at sea and by at least 30% microplastics released into the environment.
- Contribution to the Mission's Digital Ocean and Water Knowledge system through marine observations and open data and knowledge sharing.

1.5 REMEDIES zero-waste seaweed coating innovation objectives and implementation methodology

This section specifies the zero-waste seaweed coating specific objectives incorporating citizen science activities and demonstrating innovation gaps it fills and its short-term, long-term, and measurable expected impact.

Specific objectives of the deliverable 3.3 "Zero-waste cosmetics" within Task 3.4, including:

- Develop and demonstrate a seaweed-based, zero-waste coating as an alternative to conventional single-use plastic shampoo bottles.
- Validate the feasibility of scalable production at pilot or demonstration scale.
- Engage citizens and stakeholders through structured co-creation and citizen science activities to develop methodology to drive adoption of zero-waste cosmetics.
- Create open-access guidelines, educational materials, and replication-ready protocols for broader uptake.
- Establish measurable milestones for product performance, environmental footprint, and citizen engagement outcomes.

The project introduces a seaweed-based zero-waste coating for cosmetic applications that eliminates single-use plastic bottles, enabling circular packaging and end-to-end lifecycle transparency (Figure 4). Addresses the lack of scalable, consumer-ready, zero-waste cosmetic solutions that couple effective product performance with a verifiable reduction in plastic waste and a transparent, citizen-engaged pathway to adoption. Fills a market and societal gap between innovative, sustainable packaging materials and real-world consumer behaviour, supported by open-access, co-created demonstration protocols.

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Figure 4: Graphical representation of the seaweed zero-waste shampoo innovation. (Author: Mirica Karlovits)

As an expected short-term impact of Deliverable 3.3, the project aims to stimulate a zero-waste solution by demonstrating the technical viability of a seaweed coating as a cosmetic packaging alternative at multiple demonstration scales, and by building a citizen engagement framework that brings together diverse stakeholders (schools, policymakers, and businesses) along with replicable engagement materials, while generating initial life-cycle data and a cradle-to-gate environmental footprint for the seaweed coating process. In the medium term, the initiative seeks to validate scalable production pathways, expand stakeholder participation, and begin to quantify reductions in plastic packaging waste through pilot deployments, supported by open-access guidelines and demonstration protocols to enable replication. In the long term, its goal is to establish a scalable, circular packaging solution that significantly reduces plastic bottle waste in the cosmetics sector and informs policy incentives for zero-waste initiatives, complemented by a validated open-access repository of guidelines, tools, and metrics that enable replication and adaptation across other sectors and regions. Measurable indicators include the number of demonstration events and participants with a corresponding rise in awareness and knowledge about zero-waste cosmetics, the number of seaweed coating products produced and bottles displaced per cycle alongside cradle-to-gate reductions in plastic packaging waste, the publication of open-access guidelines and toolkits plus the release of open-data assets and dashboards, feedback scores from citizen scientists and end users, and the adoption rate among pilot retailers or partners, as well as environmental performance metrics such as preliminary carbon footprint, energy use, and resource intensity improvements versus baseline packaging.

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Chapter 2: Building upon know-how of cosmetics formulations

In this chapter, we introduce cosmetics (primarily shampoos, soaps, and shower gels) and provide background on their formulations. This knowledge is essential for both citizen-science demonstrations and potential end users to inform future decisions when selecting zero-waste solutions. As presented in the previous chapter, zero-waste is considered in all aspects, not only in production and sourcing of ingredients but also in packaging choices and end-of-life considerations. For the REMEDIES citizen-science demonstration, the preparation of the shampoo formulation - whether liquid or solid - is not mandatory, since all activities and processes rely on commercially available brands of shampoo. However, having this knowledge broadens our reach and supports a viable business model for both small and large shampoo producers seeking plastic- and packaging-free zero-waste seaweed coating options, while allowing us to pursue an open-science approach to citizen-science activities.

2.1. Solid and liquid shampoos properties, ingredients and instruction for its production

Here we present information on the properties and preparation of solid and liquid shampoos, along with a section on the use of seaweed compounds in these formulations.

2.1.1 Solid (hard) shampoo

Below is a list of the most recognised properties of the solid (hard) shampoos and their downsides.

- Holds little to no water. it's concentrated bar of surfactants, oils and other active ingredients.
- Typically rubbed directly onto wet hair to create a lather or lathered between the hands and then applied to the hair.
- Needs to be stored in a dry place to prevent it from dissolving or becoming mushy. Soap dishes with drainage are ideal.
- Generally, requires minimal packaging, often just a paper wrap or a small cardboard box, making it more eco-friendly.
- Has a lower environmental footprint due to less packaging and a smaller shipping weight and volume, reducing carbon emissions.
- Has a longer shelf life due to the lack of water, which reduces the risk of microbial growth.
- More travel-friendly as it doesn't count towards liquid limits in carry-on luggage and is less likely to spill.
- May be harder to control the amount used per wash, potentially leading to overuse or underuse until the user gets accustomed.
- Generally, less versatile in terms of altering the formula once it is set but can be customized in terms of ingredients before it is solidified.

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Mostly used ingredients to make solid shampoos are listed in Table 1 along with the percentage, role and function of each ingredient.

Table 1: Mostly utilized ingredients in liquid shampoos with their role and function when applied for use.

Name	Percentage	Role	Function
Sodium coco-sulfate	50 %	Primary surfactant	Cleansing action by removing dirt and oils from the hair and scalp
Cocamidopropyl betaine	15 %	Secondary surfactant (mild, amphoteric).	Helps boost foam and reduce the potential irritation caused by primary surfactants
Cetyl alcohol	5 %	Emollient and thickener	Moisturizing properties and helps to thicken the shampoo bar, making it more solid and stable
Shea butter	5 %	Emollient	Nourishes and conditions the hair, providing moisture and reducing dryness
Cocoa butter	5 %	Emollient	Adds moisture and helps to solidify the bar, giving it a stable structure
Essential oils (optional)	1-2 %	Fragrance and therapeutic benefits	Adds a pleasant scent and can provide additional benefits like anti-dandruff or soothing properties depending on the oil used
Distilled water	10 %	Solvent	Helps to dissolve other ingredients and blend them uniformly
Preservative (e.g., phenoxyethanol)	1 %	Antimicrobial agent	Prevents microbial growth, extending the shelf life of the shampoo
Colorants (optional)	as needed	Aesthetic additive	Adds color to the shampoo bar for visual appeal

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Below are the instructions in 5 main steps for preparing the solid shampoos:

1. Melt Phase: In a double boiler, melt the shea butter, cocoa butter, and cetyl alcohol together until fully combined.
2. Dry Phase: In a separate bowl, mix the sodium coco-sulfate with the cocamidopropyl betaine. Slowly add the melted butter mixture to the dry ingredients while stirring continuously.
3. Wet Phase: Add the distilled water to the mixture and continue to stir. Add the preservative and essential oils (if using).
4. Moulding: Pour the mixture into moulds and press it firmly. Allow it to cool and harden completely, which may take several hours.
5. Unmuolding: Once solidified, gently remove the shampoo bars from the moulds and let them cure for a day or two before use.

2.1.2 Liquid Shampoo

Below are the most recognised characteristics of liquid shampoos and their downsides.

- Contain a significant amount of water, which acts as a base to dissolve and mix other surfactants and ingredients.
- Poured into the hands and then massaged into wet hair to create a lather.
- Stored in bottles, typically plastic or glass, and do not require special considerations beyond keeping the bottle closed and in a reasonably cool place.
- Require bottles, often made of plastic, which can contribute to plastic waste unless recycled properly.
- Heavier and bulkier to ship due to water content and packaging, leading to a higher carbon footprint.
- Require preservatives to prevent microbial growth due to high water content, and generally have a shorter shelf life compared to solid formulations.
- Needs to be within airline liquid limits for carry-on luggage and can potentially spill if not sealed properly.
- Easier to measure and control the amount used per wash.
- More versatile for adding or modifying ingredients, such as additional conditioning agents, fragrances, or colorants.

List of the ingredients in liquid shampoos are presented in Table 2:

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Table 2: Ingredients of liquid shampoo with its role and function when applied for use.

Name	Percentage	Role	Function
Distilled Water	60 %	Solvent	Acts as the base and dissolves other ingredients, creating the liquid medium of the shampoo
Sodium laureth sulfate	20 %	Primary surfactant	Main cleansing action by breaking down oils and dirt
Cocamidopropyl betaine	10 %	Secondary surfactant	Enhances foaming, reduces irritation, and helps to stabilize the formula
Glycerin	3 %	Humectant	Attracts moisture to the hair and scalp, providing hydration and preventing dryness
Panthenol (vitamin B5)	1 %	Humectant and conditioning agent	Improves hair elasticity, moisture retention, and gives a smooth appearance to the hair
Hydrolyzed silk protein	1 %	Protein additive	Strengthens and repairs hair by penetrating the hair shaft and providing a protective layer
Essential oils (optional) -	1-2 %	Fragrance and therapeutic benefits	Adds a pleasant aroma and can provide other benefits based on the type of essential oil used (e.g., soothing, anti-dandruff)
Preservative (e.g., phenoxyethanol)	1 %	Antimicrobial agent	Prevents the growth of bacteria and mold, ensuring the product remains safe and effective over time
Citric Acid	Below 1 %	pH adjuster	Balances the pH of the shampoo to a scalp-friendly range (typically between 5 and 6), ensuring it is gentle and effective

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A step-by-step instruction for preparing liquid shampoos:

1. Aqueous Phase: Heat distilled water in a large mixing container to about 70°C.
2. Surfactant Phase: Slowly add sodium laureth sulfate and cocamidopropyl betaine to the heated water while stirring gently to avoid excessive foaming.
3. Humectant Phase: Add glycerin and panthenol to the mixture. Stir until fully incorporated.
4. Protein Phase: Add the hydrolyzed silk protein and continue stirring.
5. Cooling Phase: Allow the mixture to cool to room temperature, then add the preservative and essential oils.
6. pH Adjustment: Use citric acid to adjust the pH of the shampoo to between 5 and 6.
7. Bottling: Pour the finished shampoo into bottles using a funnel. Cap and label them accordingly.

2.1.3. Seaweed based ingredients in cosmetics

Lately, the interest in seaweed-based cosmetics is growing because it is a major source of active compounds with a wide range of applications. It contains a lot of bioactive compounds such as proteins, amino acids, lipids, vitamins, enzymes, minerals and many more. In addition, seaweed has a low cytotoxicity and a low allergen content. Seaweed components can be integrated into cosmetics as thickeners, antioxidants, moisturizers, emulsifiers and gelling agents. The incorporation of seaweed was successful in different physical forms. Products are commercially available in soaps, shampoos, sprays, hydrogels and creams. Extracts from seaweed are also used in facial cleansing products, masks, make-up removers, bath additives and products to prevent cellulite. Chemical fractions of seaweed also offer technical benefits and can be used to improve the texture, colour or stability of cosmetic products. The potential for utilisation makes seaweed environmentally friendly. Furthermore, algae are low cost and renewable which makes them even more attractive.

2.2. Overview of conventional packaging for cosmetics

The primary benefit of shampoo packaging is the safety and protection it provides against heat, light, moisture, and pollution. This is essential for maintaining the originality, fragrance, and quality of the shampoo until it reaches users.

2.2.1 Solid shampoo packaging

Within Table 3 packaging types, material made off, environmental impact and all-around advantages and disadvantages are presented for the solid shampoos.

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Table 3: Representation of the option for solid shampoo primary packaging.

Packaging	Material	Cost	Environmental Impact	Advantages	Disadvantages
Paper wrap	Recycled paper, kraft paper or waxed paper (the last one provides a slight barrier to moisture, helping to protect the bar	€0.02 - €0.10 per unit	Highly sustainable, biodegradable, and recyclable.	Economical, lightweight, minimal environmental impact.	Offers limited protection from moisture, can tear easily.
Cardboard Boxes	Recycled cardboard or kraft paper cardboard	€0.10 - €0.50 per unit depending on size, thickness, and print quality	Recyclable and often made from recycled materials	Provides more structure and protection than paper wraps, customizable for branding	Bulky, can be damaged by moisture
Metal tins	Reusable or tinplate	€0.50 - €2.00 per unit depending on size and material quality	Reusable and recyclable, though energy-intensive to produce.	Durable, offers good protection, reusable.	Heavier, more expensive, and can dent easily
Biodegradable or compostable materials	Plant based plastics cornstarch-based materials or other biodegradable plastics		Aligned with eco-friendly branding		Decompose faster
Glass	Less common but sometimes used for premium products			Reused and recycled	Heavier and fragile

2.2.2 Liquid shampoo packaging

Within Table 4 packaging types, material made off, environmental impact and all-around advantages and disadvantages are presented for the liquid shampoos.

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Table 4: Representation of the options as primary packaging for liquid shampoo.

Packaging	Material	Cost	Environmental Impact	Advantages	Disadvantages
Plastic bottles	PET (Polyethylene Terephthalate), HDPE (High-Density Polyethylene), or PP (Polypropylene).	€0.10 - €0.50 per unit depending on size, type of plastic, and design	Often not biodegradable, contributes to plastic waste; some plastics are recyclable, but the recycling rates vary	lightweight, durable, and can be recycled (especially PET and HDPE). cheap to produce, customizable	Environmental concerns, potential for leaching chemicals
Glass bottles	Glass	€0.30 - €2.50 per unit depending on size, design, and quality	Reusable and recyclable, but energy-intensive to produce and transport	Non-reactive, offers a premium feel, can be reused or recycled	Fragile, heavy, expensive to ship
Aluminium bottles	Aluminium	€0.50 - €2.00 per unit depending on size and finish	Reusable and highly recyclable; more eco-friendly than plastic.	Durable, lightweight, offers good protection, can be reused or recycled easily.	More expensive, can dent.
Refillable containers	Glass, aluminium, high-quality plastic	Varies widely depending on material and design (approx. €1.00 - €5.00 per unit)	Designed for multiple uses, reducing waste over time.	Reduces single-use packaging, customizable, eco-friendly	Higher initial cost, requires a system for refills.

Summary of the main assets from different material types for cosmetic packaging:

- Cheapest Options: Paper wraps and plastic bottles, though they have different environmental impacts.
- Mid-range Options: Cardboard boxes and aluminium bottles, balancing cost with sustainability.
- Most Expensive Options: Glass bottles and metal tins, offering durability and a premium feel, but with higher production and environmental costs.

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- A plastic bottle for liquid shampoo might cost around € 0.15 per unit for a standard (250 ml) size.
- A glass bottle of the same size might cost around €1.00, reflecting its premium nature and higher production cost.
- A metal tin for a solid shampoo bar could cost around € 0.75, offering durability and reusability.

2.3 Overview of the alternative brands and solutions to conventional packaging

This section provides readers with an overview of alternative cosmetic packaging designs, describing their main claimed benefits and unique value propositions for consumers. Figure 5 illustrates representative packaging options when exploring keyword "sustainable cosmetics packaging". When building a unique brand packaging can play as much as important role as a product quality itself. Plastic is still mainstream and innovations on the real alternatives in terms of volume of production are not yet seen to be in sight.

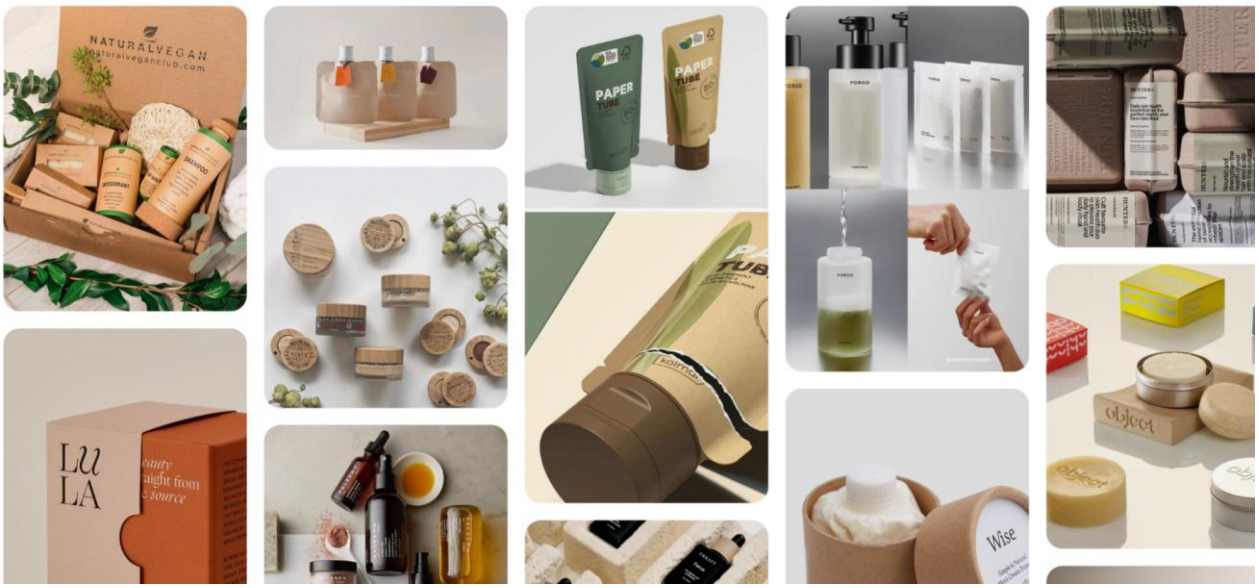

Figure 5: Representative image from Pinterest when you search for Sustainable packaging for cosmetic. (Source: Pinterest)

The following section presents the transition from design to the use of selected commercially available products from the cosmetics sector, aiming to highlight market niches and provide further insight into the claims and operational models that connect companies to consumers. In any case the evaluation of the claims is not considered to be part of this chapter. Critically minded readers may refer to section 3.3.1. for guidance on how to approach topics such as ingredients, packaging and end of life considerations.

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123zero - Sustainable hotel and outdoor festivals cosmetics in paper packaging

Figure 6: 123zero paper packaging of the shampoo gel and soap as powder (Source: online)

All 123zero beauty products for hair and body come without plastic packaging and do not contain any microplastics or water. The quantity of products is carefully thought through to avoid generating any unnecessary waste that would burden the environment.

The convenient wrapping is made from virgin paper with a biodegradable print (Figure 6). When the wrapping is opened, it gets wet and shrinks, allowing it to be disposed of in the paper bin. What remains is raw material, not waste. The contents benefit people, while the packaging benefits nature. 123zero is also part of the EU Mission "Restore our Ocean and Waters by 2030" project Inspire[16]

In Figure 7 KanKan's[17] natural ingredients formula for cosmetics is shown with aluminium packaging and a refill subscription model.

Figure 7: Demonstration of aluminium can like refill I packaging for shampoo (Source: online)

An estimated 75% of all aluminium ever produced is still in use today[18], making it an almost infinite and truly circular packaging material. It's readily recyclable in curb side recycling, durable, waterproof and rising in popularity within the beauty industry. Aluminium offers excellent protection by providing an impermeable metal barrier to light, ultraviolet rays, water vapour, oils and fats, oxygen and micro-organisms, making it an excellent material choice for protecting cosmetics, particularly skincare products, from external aggressors.

Ideally, beauty and personal care products would be packaged in materials that generate zero waste and recent innovations in the space are making this concept a reality. The body wash is transformed into a rich foam while the creative outer packaging completely dissolves when exposed to water and contains no microplastics, ensuring nothing is left behind (Figure 8)[19].

1. Cleanser is a sheet that is in a dissolvable sachet that dissolves down the drain.
2. Add-water all-over cleanser.
3. It creates foam, which you use to clean.

[16] https://inspire-europe.org/solutions/zero-waste-cosmetics/ (Accessed 1.12.2025)
[17] https://www.kankan.london/ (Accessed 1.12.2025)
[18] https://international-aluminium.org/landing/75-of-all-aluminium-ever-produced-is-still-in-use-today/ (accessed 1.12.2025)
[19] https://cleanwith.plus/ (Accessed 1.12.2025)

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4. sachets dissolve and disappears in 30 seconds with water the sachets are made of wood pulp from responsibly managed forests. The ink is bio-renewable and FDA approved.

Figure 8: Example of dissolvable naked packaging (Source: online)

The producer's claims about the product are less water, less weight, zero single-use plastic, 80 % less CO_2 emissions in shipping and 38 % less water used in manufacturing

Another approach to zero waste packaging is creating formulations that eliminate the need for packaging altogether, otherwise known as 'naked' packaging. Typically associated with soap, naked formats are now appearing in other areas of the personal care industry. From hair care cubes to solid skincare formulations personal care brands are getting creative and developing new ways to create products that offer the same benefits as their traditional counterparts, without the packaging (Figure 9)[20].

Figure 9: Beauty cubes with no primary packaging for their natural skin care line. (Source: online)

[20] https://beautykubes.co.uk/ (accessed 1.12.2025)

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Chapter 3: Zero-waste seaweed coating innovation for cosmetics and its environmental footprint assessment

3.1. Zero-waste seaweed coating innovation

As presented in the previous chapters, zero-waste is a niche within the cosmetics sector. The sector typically emphasizes sensory feel and product effects rather than the "less-waste" concept. Seaweed or its extract as a component in shampoo is rarely used and is typically present in very low amounts[21]. Thus, introducing seaweed into a shampoo formulation was considered a viable option; it can be employed mainly as a thickener and to enable efficient seaweed coating, providing protection and an aesthetic effect for the final single-use product. The innovation lies in transforming a cosmetic liquid product to be contained within a seaweed biopolymer coating that is completely plastic-free, renewable, water-soluble, and biodegradable. A seaweed coating zero-waste cosmetics evolution in shape and structure (Figure 10) and the process to meet market needs have been driven by R&D development at NIC through the BioApp project[22], coordinated by NIC. In 2021 an innovation claim was adopted at NIC for "New bioplastic for zero-waste applications" including the possible application in cosmetics. A variation of the marketable cosmetic product (custom made cosmetics formulations in solid form) without the seaweed coating was part of the R&D development at the startup company 123zero, where a NIC researcher is also a co-owner. This business case was part of the accelerator (EIT Climate-KIC Start-up Accelerator) as startup 123-zero and became an EU social innovation finalist - Challenging Plastic Waste, in 2019 as RIS cosmetics. The zero-waste cosmetic products, called Shampoo Marble, has been pilot-tested at different Slovenian Eco Resorts by 123zero cosmetics, thus reaching TRL 6-7 for the product that consist of 123zero shampoo shower gel and soap formulation. In REMEDIES, the combined emphasis on seaweed coating technology innovation at technology readiness level (TRL) 7+ and societal readiness level (SRL) 7+ will be the final phases of the market exploitation. This increases includes refining the seaweed-based coating solution to ensure robust performance under real-world conditions, optimizing manufacturing and application processes, and validating durability, safety, and cost-effectiveness. Following refinement, the project will move into implementation, piloting the coating, demonstrating scalability, integration with existing products, and feasibility within regulatory frameworks. Dissemination and impact activities will be broadened to strengthen societal readiness level (SRL) in practical terms. A dedicated outreach and engagement plan will target key stakeholders, including industry end-users, policymakers, regulators, and the general public. Activities will cover technical briefings, demonstrator events, case studies, open-access data and methodologies, and training workshops. The plan will emphasize result communication through multiple channels—policy briefs, technical reports, social media, webinars, and conferences—to raise awareness, facilitate knowledge transfer, and promote adoption.

[21] https://incibeauty.com/en/ingredients/3750-algin (accessed 1.12.2025)
[22] https://2014-2020.ita-slo.eu/en/bioapp (accessed 1.12.2025)

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To ensure uptake and enduring impact, the project will establish feedback loops with stakeholders to align refinements with user needs, develop scalable business models and deployment roadmaps, and map regulatory pathways and incentives. Intellectual property management, standardization efforts, and potential certification or performance standards will be addressed in parallel. Finally, a monitoring framework will track societal readiness milestones, dissemination reach, and adoption indicators, enabling adaptive adjustments to maximize real-world impact and ensure the research outcomes translate into tangible environmental and economic benefits.

Figure 10: Visual representation of the evolution in the development of the seaweed zero-waste packaging's and coatings for creams and shampoo from the time of 2018-2020 and variation of the product without coating in the shape of the ball (Source: Scientists against plastic Instagram and 123zero).

The zero-waste seaweed coating for cosmetics is an open innovation that uses seaweed-based biopolymer sodium alginate as the main film-forming biomaterial. When crosslinked with calcium and stearic acid dissolved in ethanol/water solution, it forms a coating over the shampoo, gel, or soap. In REMEDIES additional innovative approach was done to support the coating application, where only using a commercially available shampoo brands product and transformation from liquid products to zero-waste shampoo balls with seaweed coating has been done.

The know-how and trade secrets for individual shampoo brands and their formulations, along with the zero-waste coating adjustments required to serve as a single product, are maintained, as this requires a case-by-case approach. As part of the development of the single-use zero-waste cosmetics balls, this public deliverable deliberately leaves room for brands to build upon the process using a formulation customized for the seaweed coating, thus eliminating Steps 1 and step 2 (Section 3.2.) as steps for the business sector

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to explore further. The idea is to present the solution on plastic-free packaging sites currently used in the cosmetics sector, which will give additional potential to formulation producers of shampoos, shower gels, or soaps to embrace the zero-waste seaweed coating as a packaging option for single-use products.

This deliverable is focusing on the consumer behaviour change towards the zero-waste solutions, herein it is shared the process of making a cosmetics formulation using exclusively liquid shampoo, shower gels, or soap from popular brands (known to consumers) as a base to start the citizen-science demonstration of zero-waste seaweed coating solutions.

Within this chapter, a step-by-step formulation of a zero-waste seaweed coated shampoo, shower gel, or soap is presented in Figure 11.

Moreover, since this public document focuses on citizen-science demonstrations of zero-waste solutions in cosmetics, a six-step production process is described in a way that allows us to perform environmental assessment using LCA tools to analyse and generate feedback loops on the shampoo balls cradle-to-gate perspective, presented in Section 3.2, providing readers with additional knowledge about zero-waste solutions and their environmental impact.

A final section added in this chapter covers potential end-user interaction on the claims in the cosmetics sector to raise educated awareness on how our behaviour can be influenced and what can be a common outcome to be aware of greenwashing and out of context claims.

3.2. Production process of the zero-waste shampoo balls with seaweed coating

The production process is composed from six individual steps represented in Figure 11, which are represented as:

STEP1-STEP2 - cosmetics preparation (F1-F5)

STEP3-STEP4 - preparation of the balls (F6)

STEP5 - coating application (F10-F15, F20)

STEP6 - drying (F18)

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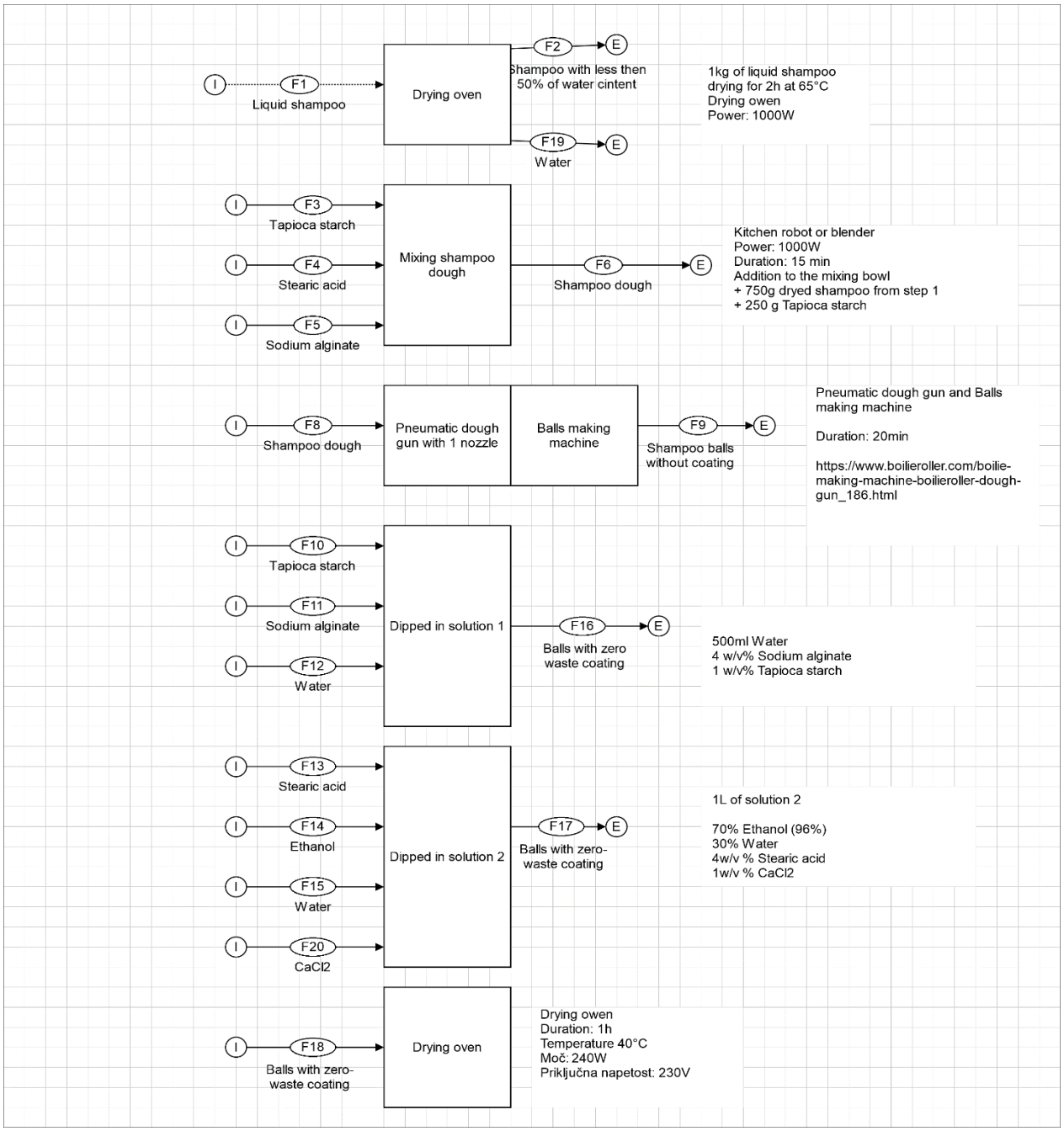

Figure 11: Scheme of zero-waste seaweed coating for shampoo or other similar type product.

The presentation of each of the steps are presented below, where the INCI[23] link is being added for more detailed examination of each ingredient.

[23] *INCI names* (International Nomenclature Cosmetic Ingredient) are systematic names internationally recognized to identify cosmetic ingredients.

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STEP 1: Choose your liquid shampoo, shower gel or soap.

For the calculation of the environmental footprint the following most common ingredient in the commercial shampoo representing above 99 % of ingredients by mass was used for calculations.

1 kg of liquid shampoo	Mass in w/w%	Link
Distillied water	60 %	https://incibeauty.com/en/ingredients/5555-aqua
Sodium Laureth Sulfate	20 %	https://incibeauty.com/en/search/k/Sodium%20Laureth%20Sulfate%20(SLES)
Cocamidopropyl Betaine	10 %	https://incibeauty.com/en/search/k/Cocamidopropyl%20Betaine
Glycerin	3 %	https://incibeauty.com/en/ingredients/6832-glycerin
Panthenol	1 %	https://incibeauty.com/en/ingredients/5791-panthenol

STEP 2. Evaporating part of water from liquid shampoo

Drying oven or air fryer

Temperature: 65˚C

Power: 1000W

Duration: 2h

STEP 3. Mixing of ingredients to make shampoo dough

Kitchen robot or blender

Power: 1000W

Duration: 45 min

Addition to the mixing bowl

62 w/w % dried shampoo from step 1

24-30 w/w % Tapioca starch https://incibeauty.com/en/ingredients/17551-tapioca-starch[24]

[24] it can be used instead of Sodium alginate

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5 w/w % Stearic acid https://incibeauty.com/en/ingredients/5575-stearic-acid

0-10 w/w% Sodium alginate https://incibeauty.com/en/ingredients/3750-algin[25]

STEP 4. PRODUCTION OF SHAMPOO BALLS

Pneumatic dough gun and Balls making machine.

Power: 150W

Duration: 20min

STEP 5. Coating of the shampoo balls

Dipping of the balls to the solution 1 and solution 2

Solution 1

Mixing in a blender

Power: 500W

Duration of 3 min

500 g Water (aqua) https://incibeauty.com/en/ingredients/5555-aqua

20 g Sodium alginate (4 w/v%) https://incibeauty.com/en/ingredients/3750-algin

5g Tapioca starch (1 w/v%) https://incibeauty.com/en/ingredients/17551-tapioca-starch

Solution 2

Mixing in kitchen blender

Power: 500W

Duration: 16 min

5376 g Ethanol https://incibeauty.com/en/ingredients/14307-alcohol

2624 g Water (aqua) https://incibeauty.com/en/ingredients/5555-aqua

320 g Stearic acid https://incibeauty.com/en/ingredients/5575-stearic-acid

80 g CaCl2(1w/v%) https://incibeauty.com/en/ingredients/1464-calcium-chloride

[25] Sodium alginate can be replaced by the Tapioca starch if considered Carbon footprint only

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STEP 6. Drying of coating

Drying oven

Power: 240W

Temperature: 40˚C

Duration: 1 h

3.3. Environmental footprint evaluation for the seaweed zero-waste shampoo coating

The visualization of the steps is depicted in Figure 11, and the step-by-step approach is presented in Section 3.2 representing all the process created inputs and outputs. These were used for the calculations of the carbon footprint, which considered only the materials and the production (cradle-to-gate) using Idemat 2024 Rev V1-2[26], with data on Eco-costs 2024 V1.0 for carbon footprint. The life cycle assessment (LCA) involving 19 impact categories was carried out using OpenLCA with the EcoInvent 3.11 database. For impacts calculation, we used the EF v3.1 method[27]. Because the EcoInvent database does not contain data for tapioca starch and sodium alginate, these materials were manually added using publicly available data from CarbonCloud[28].

The LCA was conducted cradle-to-gate, quantifying the impacts of different production processes and components for zero-waste cosmetics with seaweed coating. The functional unit is 1 kg of formed shampoo balls with zero-waste seaweed coating. As first approach, the carbon footprint of shampoo ball production is shown in Figure 12, where the biggest inputs come from the ingredients compared to the coating production, at an approximate ratio of 9:1. This gives as the first point to be optimized in order to reduce the inputs. Overall, around 10 kg of CO_2eq per 1 kg of the product (cradle to gate) which equates to 33.3 g of CO_2eq per wash. This is comparable to the 30.6 g per wash for a refillable glass container with dispenser pump used as a reference [29].

[26] https://idematapp.com/ (Idemat by Joost Vogtlander is licensed under CC BY-NC 4.0)

[27] The European Commission developed the Environmental Footprint 3.1 (EF 3.1)
Impact categories: Climate Change; ozone depletion; human toxicity, cancer effects; human toxicity, non-cancer effects; particulate matter; ionising radiation; photochemical ozone formation; acidification; eutrophication, terrestrial; eutrophication, freshwater; eutrophication, marine; ecotoxicity, freshwater; land use; water use; resource use, fossils; resource use, minerals and metals

[28] https://carboncloud.com/

[29] Kröhnert, H.; Stucki, M. Life Cycle Assessment of a Plant-Based, Regionally Marketed Shampoo and Analysis of Refill Options. Sustainability 2021, 13, 8478. https://doi.org/10.3390/su13158478

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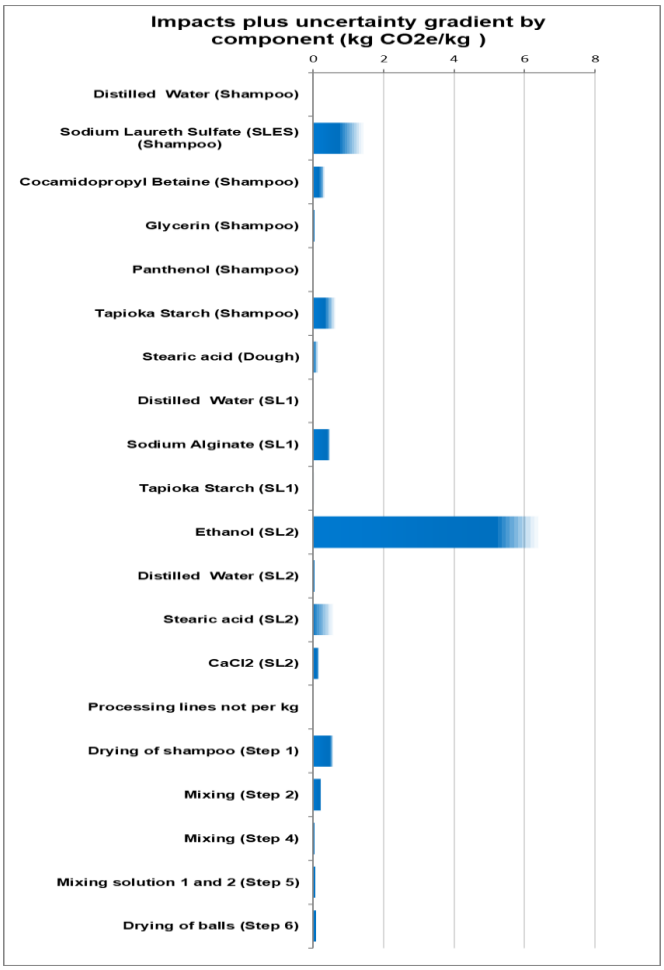

Figure 12: Carbon footprint of the 1kg of shampoo balls with zero-waste seaweed coating preparation.

It should be noted that the current Eco invent data base does not cover all ingredients, especially Asian starches and sodium alginate, resulting in a high level of uncertainty[30]. This is still a major downside with the environmental footprint calculations since the biomaterials and some natural biopolymers are not sufficiently evaluated in the Lifecycle analysis inventory databases and are mostly connected to the food sector as their main use. Furthermore, seaweed aquaculture is the fastest-growing food production sector, with strong potential to deliver low-carbon products across diverse applications. However, the global area cultivated to date is extremely small (about 0.06% of the estimated wild seaweed extent), which limits its current and near-term role in climate change mitigation. A first-order estimate using best available data indicates that, even in a low-emissions scenario, any carbon removal from seaweed farms is likely offset by emissions (median balance: −0.11 Tg C yr−1; range −2.07 to 1.95 Tg C yr−1) because farms rely heavily on fossil fuels. To achieve meaningful CO_2 removal from seaweed farming, it is necessary to decarbonise supply chains, direct harvested biomass to long-term carbon storage, expand farming beyond traditional

[30] Uncertainness options that were used for the calculations 10% for database perfect match, 30% for plausible substitution, 100% for huge differences of production facilities

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areas, and develop robust models to trace the seaweed carbon. This will bring scientific (e.g., permanence of seaweed carbon), engineering (e.g., farms in wave-exposed areas), and economic (e.g., boosting demand, lowering costs, scaling decarbonization) challenges, many of which are only beginning to be addressed. [31]

Following the study by Kröhnert et. al 2021 [23] showing absolute results for the environmental impact of shampoo per functional unit (one hair wash) the shampoo ingredients and its production and packaging correspond to only 19 % of total greenhouse gases, represented as CO_2eq emissions. The distribution (8.4 %), use phase (62 %) and product end of life (1.8%) together account for more than 80% of the total carbon footprint. A more detailed breakdown of the typical contribution to the carbon footprint of shampoo in its life cycle is presented in Table 3.

According to the life cycle assessment carried out in the study, one hair wash using the investigated shampoo is connected to greenhouse gas emissions of 161 g CO_2-eq and a resource use of non-renewable energy carriers equivalent to 2.5 MJ.

Discussion on direct comparison with the single use zero-waste cosmetics innovation shows potential for a decrease in total greenhouse gas (GHG)[32]by reducing the weight of the product used per wash from 9 g to 3 g, eliminating overuse due to pre-measured single use portions, removing the need for heavy containers, and avoiding packaging waste after use.

A 2023 benchmarking study by the Carbon Trust[33] highlights the need for brands to look beyond plastic packaging metrics and address broader environmental concerns. As calculations from the sources shown, the use phase of a shampoo accounts for up to 90 % of the total CO_2eq emissions along its life cycle (Table 5), emphasizing the need for consumer education and product innovation in the sense to support the changes in the consumer usage phase. While packaging and raw materials can be optimized using methodologies such as carbon footprint or environmental footprint to the optimization steps.

Table 5: Carbon footprint of the shampoo lifecycle cradle to cradle.

Impact Area	**Typical Contribution**	**Focus Points**
Raw Materials	30-50 %	Sourcing practices, alternative materials
Consumer Use	40-80 %	Water consumption, energy usage
Packaging	35 %	Material reduction, recyclability

Thus, our approach for employing the carbon and environmental footprint was done to optimize the formulation process, and thus the complete 19 factors environmental footprint assessment were

[31] Pessarrodona et al. Carbon removal and climate change mitigation by seaweed farming: A state of knowledge review, Science of The Total Environment, 918, 2024, 170525, https://doi.org/10.1016/j.scitotenv.2024.170525
[32] Greenhouse gases (GHGs) in the atmosphere trap infrared radiation from the Earth, keeping it warm, this is known as the greenhouse effect.
[33] https://www.carbontrust.com/ (accessed 1.12.2025)

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performed and results shown in Table 6 and Table 7, with the optimization step in the using sodium alginate or not in the shampoo dough preparation (check STEP3 in section 3.1).

Table 6: LCA results for the addition of the sodium alginate in STEP 3 (see section 3.2)

Impact category	**Reference unit**	**Result**
Acidification: terrestrial	kg SO2-Eq	0,027673
Climate change	kg CO2-Eq	5,312006
Ecotoxicity: freshwater	kg 1,4-DCB-Eq	0,284518
Ecotoxicity: marine	kg 1,4-DCB-Eq	1383,85
Ecotoxicity: terrestrial	kg 1,4-DCB-Eq	29,96778
Energy resources: non-renewable, fossil	kg oil-Eq	1,401776
Eutrophication: freshwater	kg P-Eq	0,001241
Eutrophication: marine	kg N-Eq	0,005722
Human toxicity: carcinogenic	kg 1,4-DCB-Eq	58,34641
Human toxicity: non-carcinogenic	kg 1,4-DCB-Eq	1157,129
Ionising radiation	kBq Co-60-Eq	0,169412
Land use	m2*a crop-Eq	4,527756
Material resources: metals/minerals	kg Cu-Eq	0,109324
Ozone depletion	kg CFC-11-Eq	2,09E-05
Particulate matter formation	kg PM2.5-Eq	0,011182
Photochemical oxidant formation: human health	kg NOx-Eq	0,02081
Photochemical oxidant formation: terrestrial ecosystems	kg NOx-Eq	0,022096
Water use	m3	0,211431

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Table 7: LCA results for the use only tapioca starch in the STEP 3 (see section 3.2)

Impact category	**Reference unit**	**Result**
Acidification: terrestrial	kg SO2-Eq	0,032891
Climate change	kg CO2-Eq	5,636024
Ecotoxicity: freshwater	kg 1,4-DCB-Eq	0,247252
Ecotoxicity: marine	kg 1,4-DCB-Eq	1051,622
Ecotoxicity: terrestrial	kg 1,4-DCB-Eq	21,77167
Energy resources: non-renewable, fossil	kg oil-Eq	1,480656
Eutrophication: freshwater	kg P-Eq	0,001162
Eutrophication: marine	kg N-Eq	0,005729
Human toxicity: carcinogenic	kg 1,4-DCB-Eq	53,51853
Human toxicity: non-carcinogenic	kg 1,4-DCB-Eq	869,6597
Ionising radiation	kBq Co-60-Eq	0,134736
Land use	m2*a crop-Eq	4,524573
Material resources: metals/minerals	kg Cu-Eq	0,103379
Ozone depletion	kg CFC-11-Eq	2,14E-05
Particulate matter formation	kg PM2.5-Eq	0,012775
Photochemical oxidant formation: human health	kg NOx-Eq	0,022936
Photochemical oxidant formation: terrestrial ecosystems	kg NOx-Eq	0,024272
Water use	m3	0,20215

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To support a more comprehensive optimization, we present an LCA-based environmental cost analysis with a graphical summary shown in Figure 13. Both sodium alginate and tapioca starch (variation in step 3 of the process of zero-waste shampoo) have positive impacts in certain categories. Specifically, tapioca starch (red pillars) shows the largest advantages in ecotoxicity: terrestrial, human toxicity: non-carcinogenic, and Ionising radiation. In contrast, acidification: terrestrial and particulate matter formation favour sodium alginate (green pillar) as the preferred option. An overall cost-benefit view using midpoint environmental prices (€ per impact category) yields €406.87 for Table 6 versus €304.36 for Table 7, a difference of €102. These steps do not necessarily imply a superior product or guaranteed user acceptance; rather, the LCA framework is used to evaluate the process introduced through the citizen-science demonstration for zero-waste cosmetics and to advance consideration of the gender dimension, including the potential environmental and health impacts of daily chemicals and seaweed-coating production.

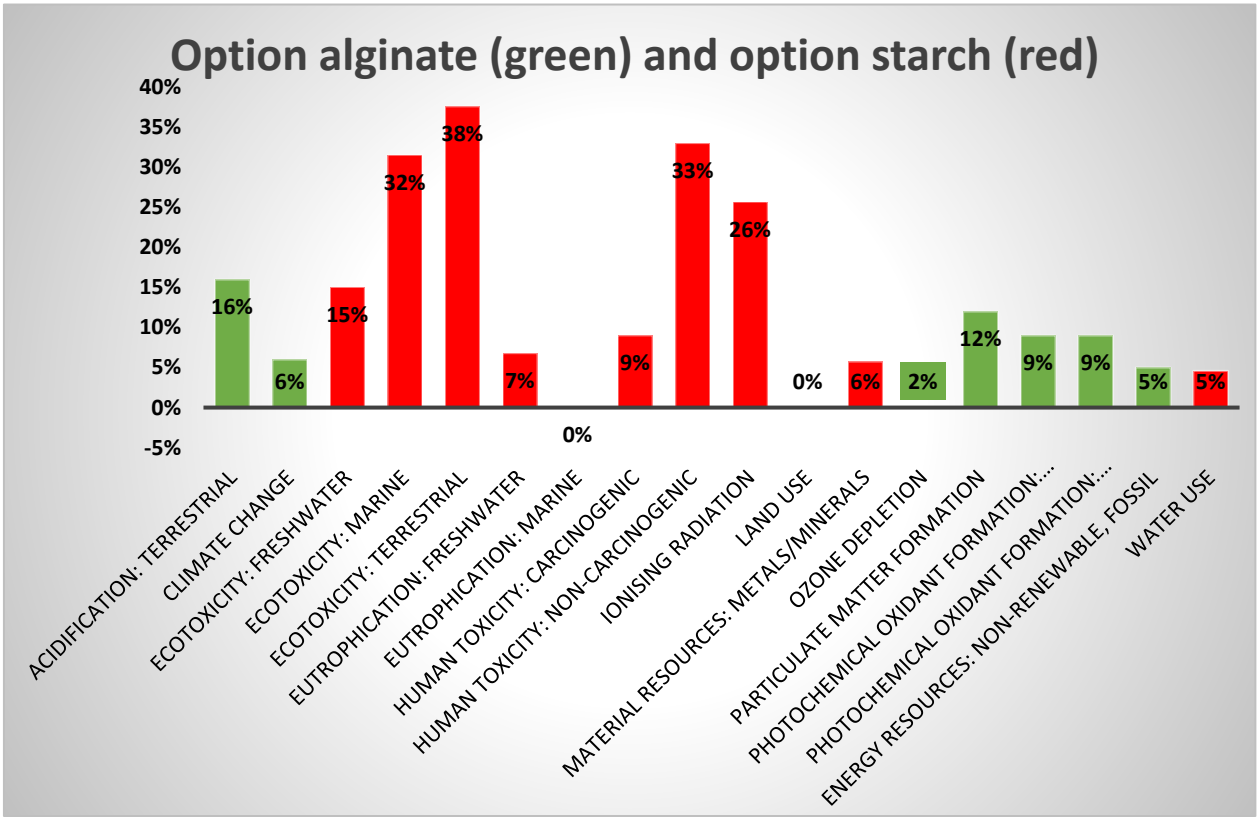

Figure 13: Difference between choice with added sodium alginate (green) and only tapioca starch (red). The values stand for the lower or improved environmental effect while colours represents if this is the case for sodium alginate added to formulation of formulation without it and replaced with tapioca starch.

3.3.1 Impact claims and greenwashing in cosmetics brands

LCA results are often vulnerable to manipulation in the cosmetics sector through methodological choices, selective boundaries, cherry-picked impact categories, or favourable allocation rules, which can make products appear better than they are. Transparency helps counter this. For shampoos, key manipulations

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include omitting chemical formula impacts and focusing narrowly on carbon while downplaying water toxicity. Pervasive greenwashing often blends "free-from" fearmongering with "natural" imagery to imply sustainability, usually without holistic lifecycle data to back it up.

True impact involves publishing full LCAs, reformulating for biodegradability and low aquatic toxicity, using post-consumer recycled plastic transparently, and innovating in refill systems that tackle the core issue of single-use packaging.

Table 8: LCA based manipulation issues connected to the greenwashing outcome.

Issue	**How It's manipulated**	**The greenwashing[34] outcome**
1. Boundaries selection (The "Bottle-Only" LCA)	Excluding the impacts of the shampoo formula itself, focusing solely on packaging (e.g., "Our bottle is made from 50 % recycled plastic!").	Hides the significant environmental burden of chemical production, water consumption in formulation, and manufacturing energy.
2. Functional unit trickery	Using a non-standard functional unit (e.g., "*per wash*" vs. the standard "per millilitre of product"). A "concentrated" shampoo uses less per wash but may have a more impactful formula per ml.	Makes direct comparison with competitors impossible. A brand can claim lower impacts "per wash" while the bottle's total impact is higher.
3. Impact category omission (The "carbon-only" focus)	Reporting only global warming potential (GWP/carbon footprint) while ignoring:	Presents a "green" carbon footprint while the product pollutes waterways and ecosystems. This is one of the most common and damaging forms of greenwashing.
	• Eutrophication (from phosphates & surfactants in wastewater).	
	• Ecotoxicity (from preservatives, fragrances, silicones).	
	• Water scarcity (water as an ingredient & in manufacturing).	

[34] Greenwashing is defined as the dissemination of misleading or deceptive publicity by an organization with the aim of presenting an environmentally responsible public image.

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4. Allocation & end-of-life assumptions	• Allocation: Assigning negative impacts of palm oil derivatives to the "food industry" only, not the cosmetic fraction.	Artificially lowers impacts of controversial ingredients and packaging. Creates a fantasy scenario for disposal that doesn't match reality.
	• End-of-Life: Assuming 100 % of bottles are recycled in regions with low recycling rates or ignoring microplastic shedding from product use.	
5. Data source bias	Using industry-funded or outdated datasets for key ingredients (e.g., sulfates, silicones, parabens) that underestimate their environmental toxicity or resource intensity.	Makes a favorable bias from the start, making the LCA a legitimizing tool rather than an objective assessment.

How to find credible claims:

- Transparency: Can you find the full LCA report (or a detailed summary) on their website? Look for compliance with ISO 14040/14044 standards.
- Scope: Does the assessment cover cradle-to-grave (raw materials to disposal) and all major environmental impact categories?
- Third-Party: Is the LCA or claim verified by an independent, accredited body?
- Specificity: Do they make specific, measurable claims ("30 % recycled plastic in our bottle") rather than vague ones ("kind to the planet")?
- Certifications: Do they hold legitimate, multi-criteria certifications? Check what the certification covers (e.g., COSMOS[35] covers sourcing, manufacturing, environ. management).

3.3.2 "Zero-waste" claims in cosmetics

"Zero-waste" claims in cosmetics, especially shampoos, are a major frontier for greenwashing. While the intent is good, the execution is often flawed. Let's break down the realities, manipulations, and how to spot them.

[35] https://www.cosmos-standard.org/en/certification/cosmos-certification/ (accessed 1.12.2025)

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Table 9: Claims in zero-waste cosmetics from companies or brands perspective

Claim type	Typical representation	The reality & common pitfalls
1. "Zero-waste to landfill" (Corporate)	"Our manufacturing facility is zero waste!"	This often means industrial incineration with energy recovery is counted as "diverted from landfill." It's a waste management claim, not a product design claim. The product's packaging can still be non-recyclable.
2. "Recyclable packaging"	"Our bottle is 100 % recyclable!"	The #1 greenwashing claim in packaging. Assumes perfect consumer behavior and infrastructure. Most shampoo components (pumps, caps, labels, multi-material tubes) are not recyclable in curbside programs. The claim ignores reality.
3. "Made from recycled material"	"Contains 50% recycled plastic!" (Often - Post-Consumer Recycled).	A good step, but not "zero waste." It's a linear solution in a circular economy. The bottle will likely become waste again after use. Doesn't address overproduction or end-of-life.
4. "Compostable" or "biodegradable" packaging	"Our pouch is home-compostable!"	High risk of greenwashing. Most require industrial composting facilities (rarely accessible). If placed in recycling, they contaminate streams. In landfill, they produce methane. The claim often lacks proper certification (e.g., TÜV OK compost HOME[36]).
5. "Refillable system"	"Buy our durable bottle once, then purchase refill pouches."	The most promising model, but with caveats. Problems: • The refill pouch is often non-recyclable (multi-layer plastic). • Low return/refill rates (studies show often <30 %). • The carbon footprint of cleaning & transporting the durable bottle may offset gains if not optimized.

[36] https://en.tuv.at/ok-compost-home-en/ (accessed 1.12.2025)

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6. "Package-free" (solid bars)	"Shampoo bar wrapped in paper."	Closest to true zero waste, but not perfect. Issues:
		• The paper wrapping may be coated in plastic (polyethylene) for moisture barrier.
		• The bar's formula itself has a lifecycle impact.
		• Transport emissions can be higher per wash vs. concentrated liquids.

How to assess "zero-waste" claims rigorously

- At what level is "zero-waste" claimed?
    - Product? (The entire lifecycle)
    - Packaging only? (Just what you hold)
    - Corporate operations? (Their factories - less relevant to you)
- What is the exact end-of-life pathway for *every* component?
    - Bottle, cap, pump, label, box, liner.
    - Demand specifics: "Is the pump dismantlable and accepted by my local recycling?"
- Is there a take-back program?
    - The gold standard. Does the brand physically take back its packaging for refill, reuse, or proper recycling? (e.g., Lush's black pot return, Loop platform partnerships).
- What third-party certifications back the claim?
    - How2Recycle Label (clear, store-drop-off instructions).
    - Cradle to Cradle Certified (includes material health & reutilization).
    - ASTM/ISO standards for compostability (not just the word).
- Does the brand measure and disclose refill return rates?
    - Transparency on the actual reuse rate of their system is critical.

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3.3.3 Innovation such as seaweed-based water-soluble coating claims

In this case we are introducing so called functional packaging[37] scenario where the packaging is part of the product. This is a fascinating innovation, but it introduces a new layer of complexity and potential greenwashing.

Critical Challenges & Greenwashing Risks

Even in this advanced model, significant pitfalls might exist.

1. Formula stability & preservation

- Seaweed coatings are hygroscopic (absorb moisture). In a humid bathroom, the bar could become sticky, degrade, or grow mold.
- Preservation challenge: If the coating is "all-natural," it may lack preservatives, risking microbial growth. Adding preservatives contradicts "pure" marketing.
- Shelf-life reduction could lead to higher product waste—offsetting packaging savings.

2. Ingredient compatibility & efficacy

- Shampoo formulas are highly engineered. Adding dissolved coating ingredients could:
    - Disrupt surfactant chemistry, reducing lather.
    - Interfere with functional ingredients (e.g., anti-dandruff actives).
    - Cause unexpected interactions (pH changes, precipitation).
- Dosage control: How much coating is needed for packaging integrity vs. hair benefit? Too much may leave residue.

Supply chain & lifecycle impacts are depicted in Table 10

Table 10: What are the hidden impacts seaweed coatings solutions

Stage	Hidden impact
Seaweed farming	Large-scale demand could lead to monoculture, habitat disruption, or unsustainable harvesting.
Processing	Converting seaweed to a stable, functional coating likely requires energy-intensive drying and chemical modification.
Transport	Coated bars may need climate-controlled shipping (refrigeration) to prevent melting/degradation, increasing carbon footprint.
End-of-life	If the user dislikes the coating and rinses it off unused, it becomes wastewater pollution - not "zero waste."

[37] Functional packaging – packaging designed to do more than simply contain a product – is rapidly transforming the industry. It incorporates features that add value for consumers, such as convenience, freshness, safety, or interactivity

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Greenwashing tactics in this case can be seen in Table 11

Table 11: Greenwashing tactics

Tactic	Reality check
"Packaging-free"	Technically true, but the coating still serves a packaging function and has its own environmental footprint.
"Beneficial Packaging"	Claims of hair benefits may be overstated or unproven. Cosmetic claims require clinical testing.
"100 % Natural"	Coated bars may need climate-controlled shipping (refrigeration) to prevent melting/degradation, increasing carbon footprint.
End-of-life	Even if coating is pure seaweed, the core shampoo formula likely contains synthetics (preservatives, surfactants).
"Circular"	Unless the seaweed is sourced from regenerative aquaculture and the carbon footprint is net-negative, it's not truly circular.

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Chapter 4: Co-development and co-creation of citizen science demonstrations protocols

4.1. Introduction to citizen science

Citizen science is the public participating *"in scientific research activities when citizens actively contribute to science either with their intellectual effort or surrounding knowledge or with their tools and resources"* (European Commission, 2014). The term covers a range of activities with different levels of participation, from data collection in projects led by trained scientists to co-designing research questions and policy, to science literacy and public engagement. For activities to truly be considered citizen science, it is important that projects have the intention to contribute to research, to produce new research-based knowledge, and for their activities to be carried out by participating citizens. Citizen participation is inherent to citizen science projects and their goals. Citizen science is seen as versatile approach to scientific research, adaptable across various scientific disciplines and contexts. The European Citizen Science Association (ECSA) formulated its principles through the efforts of the "*Sharing Best Practice and Building Capacity*" working group. This specialized group, spearheaded by the Natural History Museum in London and aided by ECSA members, crafted essential principles that lay the foundation for high-quality practices in citizen science. They have been written down in a document ten Principles of citizen science[38].

Summary of the 10 citizen science principles:

1. Citizen science projects engage community members actively in scientific endeavours, generating new knowledge. Participants can assume various roles, which should be clearly defined and transparent.

2. Citizen science projects yield tangible scientific outcomes.

3. Both professional scientists and other participants in citizen science projects derive benefits, which can range from scientific publications, knowledge exchange, personal fulfilment, societal advantages, to the influence and satisfaction of seeing research outcomes shape solutions in local, national, or international contexts.

4. Participants in citizen science projects can contribute to different stages of the scientific process, including research design, development of scientific methods, data generation, and the publication and dissemination of results.

5. All participants are kept informed about the progress of the research, including phases they may not be directly involved in, like the impact of the research on social development or the implementation of findings in various contexts.

[38] ECSA (European Citizen Science Association). 2015. Ten Principles of Citizen Science. Berlin. http://doi.org/10.17605/OSF.IO/XPR2N (accessed 6.6.2025)

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6. Citizen science is as valid as any traditional research method, but it has its own limitations and biases that must be acknowledged and addressed. Unlike conventional research models, citizen science promotes community involvement and the democratization of science.

7. Citizen science adheres to open science principles. Data and metadata from projects are made publicly available, and results are published in open access formats, subject to standard exceptions for sharing research findings.

8. All participants should receive acknowledgment in the research outputs of citizen science projects.

9. Evaluation of citizen science programs should consider research results, data quality, participant experiences, and broader social or political impacts.

10. Leaders of citizen science projects must consider legal and ethical aspects, including copyright, intellectual property, data sharing agreements, confidentiality, citation, and environmental impacts in their research activities.

Additionally, citizen science is often confused with other forms of participatory projects, such as science education, science communication, and outreach activities. Kasperowski et al[39] identifies three main forms of citizen science: 1) Citizen Science as a research method, aiming for scientific output, 2) Citizen Science as public engagement, aiming to establish legitimacy for science and science policy in society, and, 3) Citizen Science as civic mobilization, aiming for legal or political influence in relation to specific issues. The number 2 and number 3 were explored within the REMEDIES as citizen science demonstration, while number 1 will be explored as final step in the exploitation phase of the project.

All the above provide us with a loose definition of what can be considered as citizen science, which is both an advantage and a challenge for the growing community of practitioners of citizen science, who are continuing to establish the methods of citizen science as recognized scientific practices.[40]

4.2. Citizen science methodological approach

This public deliverable serves as a demonstrator of citizen science and as a pioneering example of how citizen science can accelerate the preparation of the methodology to support adoption of environmentally friendlier products, reduce cosmetic waste, and promote sustainable consumption patterns within communities. It is closely related to, and in some instances blurs into, citizen education and engagement.

As the REMEDIES and NIC team, "Scientists Against Plastic,"[41] began in 2017, we educate and inform citizens on the subject matter, leading to greater public understanding of how science and scientists' work.

[39] D. Kasperowski, C. Kullenberg, Å. Mäkitalo, Embedding Citizen Science in Research: Forms of engagement, scientific output and values for science, policy and society, (2017). doi:10.31235/osf.io/tfsgh_v1
[40] Eitzel, M V, et al. "Citizen Science Terminology Matters: Exploring Key Terms". *Citizen Science: Theory and Practice*, vol. 2, no. 1, 2017, p. 1.
[41] Group Scientists against plastic https://www.instagram.com/scientists_against_plastic/ (accessed 10.12.2025)

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Figure 14 provides a visual representation of the activities, which underpin the funding basis for pursuing citizen-science demonstration activities through sharing know-how and open science with volunteers, schools, policymakers, entrepreneurs, and the general public. The main motivation of our work is to increase trust in science and expert opinions, enhance critical thinking, and ultimately counter misinformation, disinformation, and fake news. Thus, these activities have evolved to embrace the citizen-science segment.

Within the REMEDIES citizen-science demonstrations to support the zero-waste plastic-conscious society is a primary objective, using surveys and engagement in the co-creation process, and, for the most part, citizen engagement and awareness-raising. Innovations and market trends, along with policy pushes described in previous chapters, provide a perfect opportunity to tackle the citizen-science approach. Making scientific innovation open to experimentation and adaptable by citizens enables novel, inclusive approaches, such as the demonstration of citizen science for zero-waste seaweed coatings.

The aim is not only to determine whether citizen science can meet standards of good scientific practice but also to view citizen science as public engagement and as civic mobilization. In the zero-waste cosmetics case, the methodology was refined by testing different approaches (Chapter 5) with different audiences, locations, and interests, yielding a multi-step optimization that creates toolkits to successfully perform citizen science activities (Chapter 6), which are replicable and customizable by other stakeholders, bridging the scientific approach to modern, environmentally friendlier solutions for homes, schools, universities, and businesses. For assessing impact, a survey-based approach was used to enable citizen participation and share outcomes as open-source results on the REMEDIES dashboard. Moreover, a workshop-style demonstration of zero-waste cosmetics provides additional collaborative ways to improve knowledge sharing and citizen engagement, reinforcing that we can be part of the solution when addressing plastic alternatives in cosmetics.

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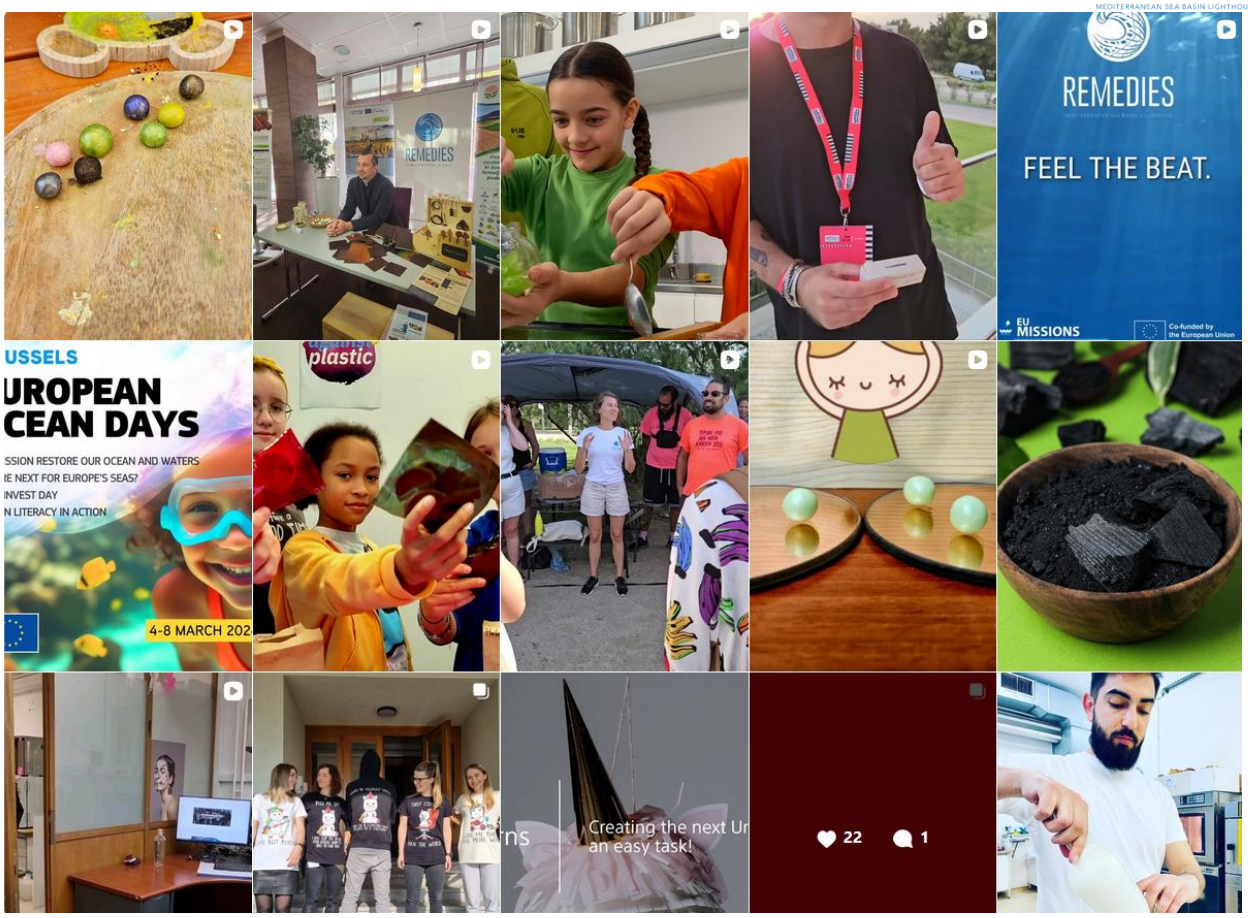

Figure 14: Print screen of recent post from Scientists against plastic Instagram page. (Source: online)

4.2.1. Gender dimension in citizen science supported innovations

Gender refers to the roles, behaviours, activities, and attributes that a given society at a given time considers appropriate for people of different genders. Cultural and social contexts, including characteristics such as age, ethnicity, socialization, economic background, and education, co-determine the understanding of gender and associated gender-specific roles and identities. A gender-responsive approach does not focus solely on women, nor solely on men. By contrast, sex refers to the physical and biological characteristics by which most societies distinguish males and females. However, research shows that sex can be more complex than the traditional male-female binary. Within Horizon Europe programs, the gender dimension involves analysing and considering possible differences between men and women (biological characteristics as well as social and cultural features), boys and girls, or males and females, in the R&I content of the project (Figure 15).

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Integrating this gender dimension is now a mandatory requirement in all research and innovation projects across Horizon Europe, unless a topic explicitly specifies otherwise[42]. Hence, it shall be integrated where relevant as it can affect research questions, methodology, data, outcomes, and impacts.

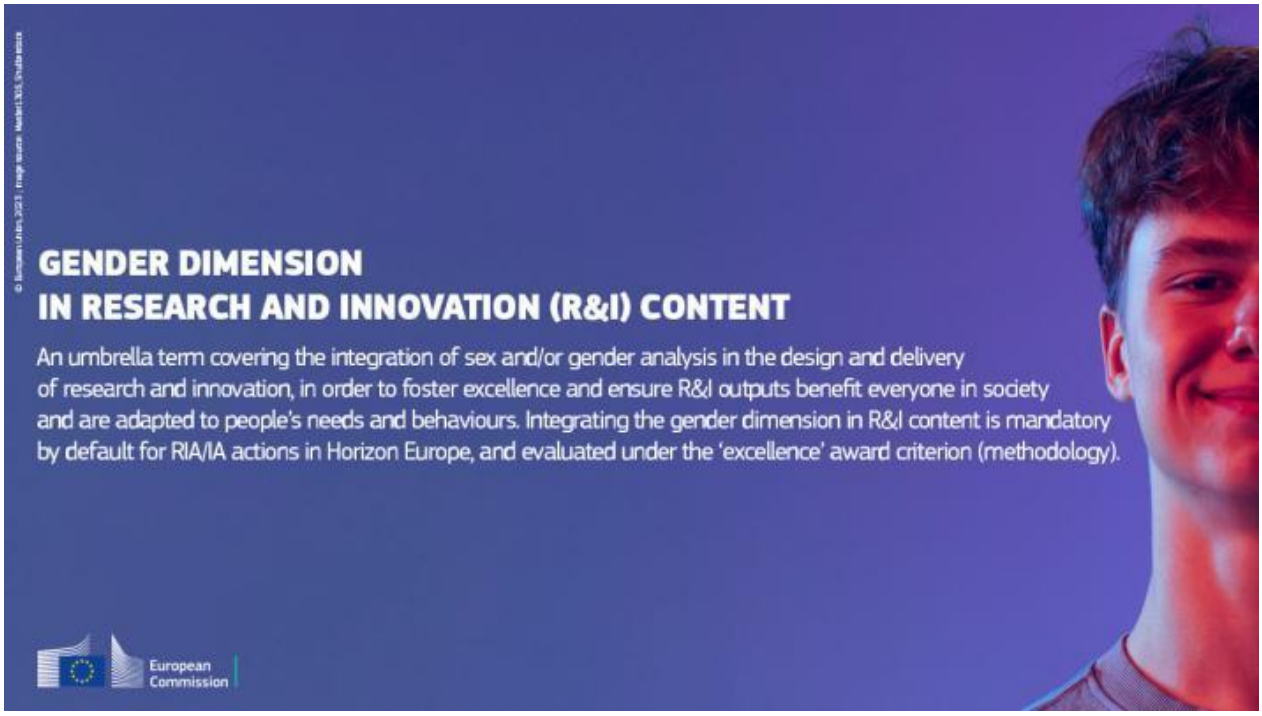

Figure 15: European Commission demonstration of gender dimension in research and innovation content. © European Union, 2023; image source: Master1305, Shutterstock

As part of the zero-waste cosmetics citizen-science demonstrations, a gender-dimension factor was acknowledged to ensure chemical safety for all genders, in line with gender-inclusive communication and branding. Guidelines and toolkits for replicating citizen-science workshops consider gender and strive for an unbiased approach. Promoting shampoo ingredients does not focus on one gender as the main buyer but rather builds on everyone's qualities and needs as provided by zero-waste cosmetics. The zero-waste seaweed coating innovation provides equal opportunities for all genders, and through our co-creation methodology, participants can choose or adapt guidelines, deciding how they influence the final product, thereby nurturing a gender-unbiased, stereotype-free culture. Finally, all surveys collecting feedback, know-how, and outcomes from the citizen-education and science activities embed the gender dimension to give researchers insight into gender impacts.

4.3. Zero-waste cosmetics: a gender-inclusive citizen science protocol

As a main part of building and demonstrating a citizen science supported activity is REMEDIES zero-waste pillar and the zero-waste seaweed coating innovation the educational and capacity identification of shown

[42] https://rea.ec.europa.eu/gender-eu-research-and-innovation_en#gender-dimension-versus-gender-balance (Accessed 1.12.2025)

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in Figure 16 were further connected with the Gender dimension, which is mostly ignored when considering citizen science activities as demonstrated by the definitions in section 4.1. As a main result of the citizen science activities presented in Chapter 6 is developed methodology. While the other

Figure 16: Activities involving gender dimension REMEDIES zero-waste cosmetics citizen participation/science.

Developing the Methodology

In citizen science initiatives focused on zero-waste cosmetics, robust methodology involved designing inclusive participatory frameworks that recognize gender diversity and promote equitable participation. This includes co-creating protocols that consider different gender perspectives, needs, and experiences, ensuring that formulations are suitable and accessible for all users. Training participants on sustainable practices and safe ingredient handling should be sensitive to gender-specific concerns, fostering an environment where diverse voices contribute to the development of environmentally friendly cosmetics.

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A gender-sensitive methodology ensures that outcomes are not only scientifically sound but also socially equitable and responsive to varied community needs.

Research questions

Formulating research questions with a gender perspective addressed disparities and ensured inclusivity in the campaign's focus. Questions explore how zero-waste cosmetic formulations cater to different gender-specific skin and hair types or preferences, or how gender influences consumer acceptance and usage patterns. Investigating barriers faced by different genders in adopting sustainable cosmetics, as well as the social perceptions surrounding gender and beauty standards, ensures that the research is comprehensive and equitable. Incorporating gender considerations ensures that the citizen science collected data through campaign's promote inclusivity and address diverse needs.

Interpretation of solutions

Interpreting solutions within a gender-sensitive framework involved analysing data and feedback from a perspective that recognizes gender differences in experiences, preferences, and usage patterns. This included examining whether formulations and especially coatings final appearances are effective and appealing across gender groups and identifying gender-specific barriers or facilitators to adoption. Engaging participants from diverse genders in interpreting solutions fostered a more holistic understanding of the impacts and helped to tailor formulations and strategies that are inclusive, equitable, and responsive to all community members' needs.

Impact

The impact of the citizen science campaign extends to promoting gender equality by empowering individuals of all gender identities to participate in zero-waste plastic free innovation in the cosmetics sector. It challenged gender stereotypes related to beauty and cosmetics, fostering more inclusive narratives around sustainability and self-care. The campaign's success has the potential to inspire more equitable access to eco-friendly products, influence industry practices to be more gender-responsive, and contribute to policy changes that recognize gender diversity in environmental and health considerations. Measured impact includes assessing how the initiative advances gender equity in participation, access, and benefits.

Sharing and Communicating Results

Shared and communicating results with a gender lens where messaging is inclusive and accessible to all genders. This involved creating content that highlights diverse voices and experiences, and addressing gender-specific benefits or concerns related to zero-waste cosmetics. Transparent and gender-sensitive communication fosters trust, encourages broader participation among underrepresented groups, and promotes an understanding of how zero-waste practices can serve everyone equally. With the inclusive storytelling amplifies the campaign's relevance and reinforces commitments to gender equality.

Co-Design

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Co-design in this context emphasized the importance of involving people of all genders in developing formulations, research strategies, and outreach activities. This participatory approach recognized gender as a social determinant that influences access, preferences, and perceptions of cosmetics. By actively engaging diverse gender groups, the co-design process distinguished the solutions that are culturally relevant, socially equitable, and better tailored to meet the needs of all community members. It also helped challenge gender stereotypes and promoted inclusive innovation.

Task Design

Designed tasks with a gender perspective involved ensuring that activities are accessible and appealing to participants of all genders. Tasks were flexible, culturally sensitive, and mindful of potential gender-based barriers, such as caregiving responsibilities or social norms. Clear instructions and support systems fostered inclusive participation, enabling diverse community members to contribute meaningfully. Thoughtful task design helped build confidence, encouraged sustained involvement, and ensured that data collection with surveying and feedback via performed outreach efforts reflected diverse experiences and needs.

Evaluation and Assessment of Impact

Evaluating the impact of the campaign with a gender lens involves analysing how participation and benefits are distributed across different gender groups. This included assessing whether the initiative promotes gender equity in access to sustainable cosmetics, knowledge, and influence. Data collection was designed to disaggregate by gender to understand disparities and barriers, and to identify opportunities for more inclusive engagement. Continuous evaluation ensured that the campaign's progress toward gender equality was monitored and that strategies could be adapted to be more inclusive and effective.

Impact Policy-Related Activities

Zero-waste citizen science activities are built in the sense to influence policy by including and highlighting gender disparities and advocating for gender-sensitive approaches to chemicals and approaches leading to potential different effect on different genders though out the whole life cycle. Engaged diverse gender groups in policy discussions, workshops, and advocacy efforts are awarded and consideration is made that regulations and incentive programs address the specific needs and barriers faced by different genders. Policies that recognize gender diversity in environmental and health initiatives promote more equitable access to sustainable products and support gender-inclusive innovation. These activities helped to foster a more just and inclusive transition toward zero-waste cosmetics and sustainable practices at the policy level.

Within each of the activities represented citizen science demonstrating zero-waste cosmetics were built in the events described in the next Chapter 5, while the additional toolkits co-created and codeveloped from the citizens and experts from other discipliners are presented in Chapter 6 together with the survey for results harvesting and co-creation process of zero-waste cosmetics.

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Chapter 5: REMEDIES workshops and events with

5.1. Stakeholders identified in the activity's timeline

In this project, the environment and context for stakeholder engagement are such that many individuals were not aware of the activity beforehand. Consequently, feedback from participants was collected in the way to firstly improve the engagement and satisfaction of the participant, thus building a platform that can show a real case of citizen science as a tool to support the behavioural change and zero-waste products innovations. Publicly available data from the workshops and the open participation platform via REMEDIES web page and REMEDIES dashboard is foreseen to operate in 2026 and beyond.

To organize and interpret stakeholder input, the power/interest matrix was used as the primary analytical tool. This matrix synthesizes outputs from participant participation and the involvement of organizations in the workshops and events focused on zero-waste cosmetics. In section 5.2 it is presented all the 19 workshop and/or event in greater detail, including an impact assessment that encompasses reach (audience size), level of participation, and the depth of interaction with participants, as well as coverage in public events and media.

A list of identified stakeholders[43] is presented below and has been positioned according to their power and interest as shown in Figure 17. The citizen-science approach to zero-waste cosmetics shows a dual dynamic: it is propelled both by the push from plastics-alternative perspectives and by key players with high interest and high influence. These stakeholders are described and categorized to inform strategic engagement and resource allocation.

The matrix comprises four quadrants:

- Keep satisfied (high power, low interest)
- Monitor/keep informed (low power, high interest)
- Key players (high power, high interest)
- Minimal effort (low power, low interest)

[43] Environmental / water / plastic related NGOs - Civic Society, Municipalities/Regions, Local Entrepreneurs, Conscious Consumers, Private Funds / Impact Funds, Scientific community, Educational institutions, Other H2020 - EU Green Deal - EU Mission - EU related projects, European Commission, Policy makers, Industry Companies, Journalists, General public, Potential end-users Supporters, Social media Influencers

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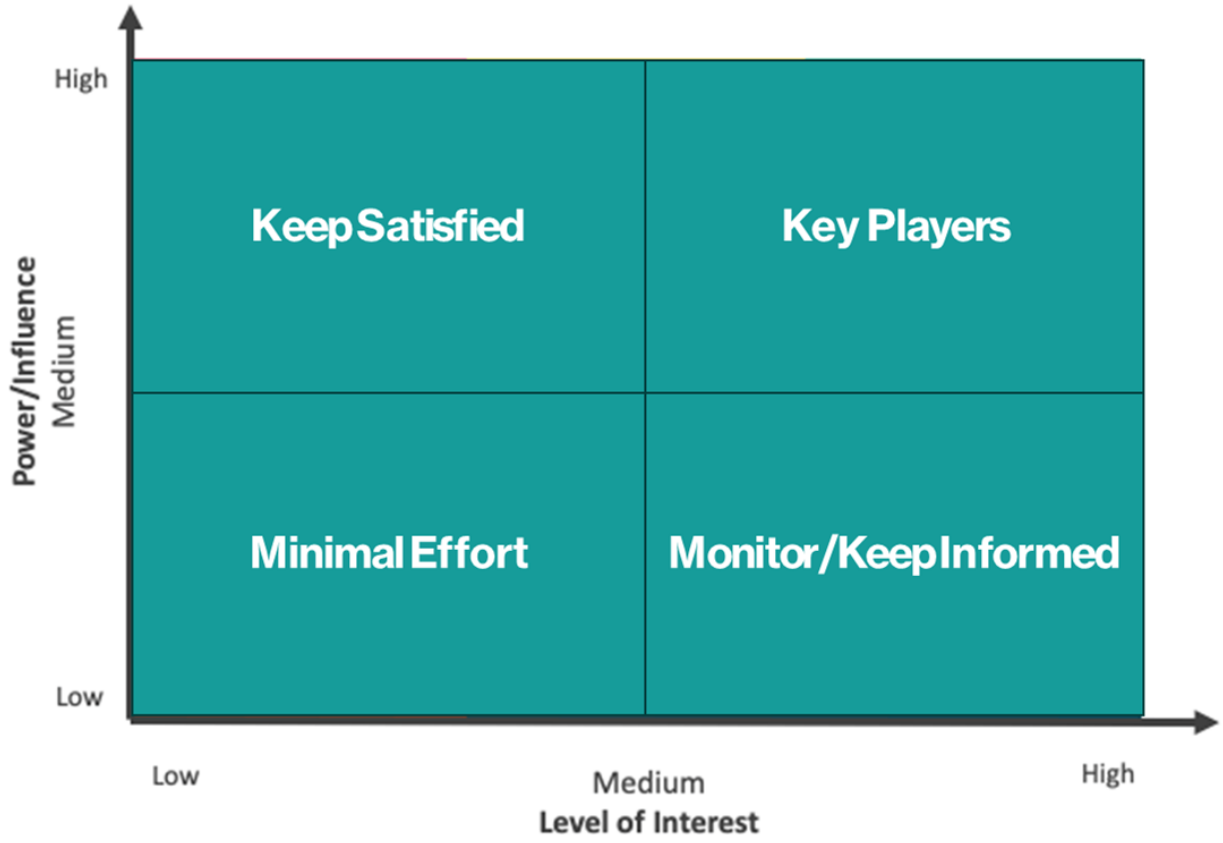

Figure 17: Matrix of stakeholders mapping based on their power to interest.

Each stakeholder group was assed base on the pre-existing experience and on the identified trends as described in previous chapters and were as a final touch updated from the experience from the workshops events where REMEDIES partners participated to demonstrate zero-waste cosmetics.

As Key players with identified high power and high interest were:

- Municipalities/Regions (local government, urban planning): Regulatory levers, procurement policies for cosmetics, bans on single-use packaging in municipal facilities, support for local zero-waste programs.
- Policy Makers / European Commission / EU Green Deal / EU Mission / EU related projects: Sets overarching targets, funding streams, harmonization of standards, consumer labelling requirements.
- Private Funds / Impact Funds (investors focused on sustainability): Financing for zero-waste supply chains, circular packaging R&D, scale-up of refill/reuse models.
- Educational Institutions / Scientific Community (universities, research centres): R&D on sustainable formulations, life-cycle analyses, consumer behaviour insights; credibility and evidence to drive policy and practice.

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- Industry Companies (cosmetics brands, packaging manufacturers, retailers): Route-to-market for zero-waste products, reformulation, packaging redesign, scaling reuse programs; potential policy lobby or compliance considerations.
- Journalists / Media (science and business press): public communication, framing of behavioural-change initiatives, transparency about sustainability claims.

High Power, High Interest engagement approach:

- Co-create policy pilots, funding applications, and standards.
- Share rigorous evidence (LCA, safety, efficacy) to drive adoption.
- Develop joint roadmaps for packaging redesign and refill/reuse infrastructure.
- Transparent reporting on progress, challenges, and consumer outcomes.

As a keep informed stakeholders with a medium power and high interest were identified:

- Conscious consumers / General public / Potential end-users: High interest in personal impact and ease of adoption but variable influence.
- Local entrepreneurs / Small and medium enterprises (SMEs) in cosmetics and packaging: Willing to innovate, constrained by capital and scale; potential to pilot local zero-waste systems.
- School children / Teachers (education sector): High interest in learning and behavioural change; can serve as catalysts in schools and communities.

Engagement approach:

- Create culturally appropriate education materials, school programs, citizen science opportunities.
- Pilot community refill stations and local repair/reuse hubs; provide micro-grants or challenges to pilot ideas.
- Communicate clear benefits, safety assurances, and simple steps for households.

As final group of the interest to monitor and keep informed with up to medium power, low to medium interest were identified:

- NGOs (environmental / water / plastic-related): Motivated, but variability in scope and influence; can advocate and partner on pilots.
- General Public (broader audience): Interest generally moderate; targeted campaigns needed to move them from awareness to action.
- Educational Institutions (non-research): Teachers, schools beyond tertiary education; interest in curriculum integration, but may have limited capacity.

- Social media influencers: Influencers that specially focus on the zero-waste lifestyle or plastics free alternatives are mainly interested in product following their engagement.

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Following this exercise and the experiences gathered from the workshops and events described in the next section, the citizen-science activities were developed and evaluated. As a main results of the citizen science activities a cocreation of the comprehensive methodology and toolkit, detailed in Chapter 6, has been prepared. The ultimate aim from a citizen science and engagement perspective is to prepare an open access scientific publication covering all participations, with a focus on the event-type workshops conducted by the NIC team as well as by other institutions, using the methodology cocreated with citizen science. From a dissemination perspective, the impact will be assessed based on participant engagement and reach number of the seaweed coating product as well made.

5.2. REMEDIES citizen science demonstration activities

Following the main key performance indicators (number of workshops, number of Mediterranean countries and number of engaged citizens for the zero-waste seaweed coating are presented in Figure 18 and in Table 12.

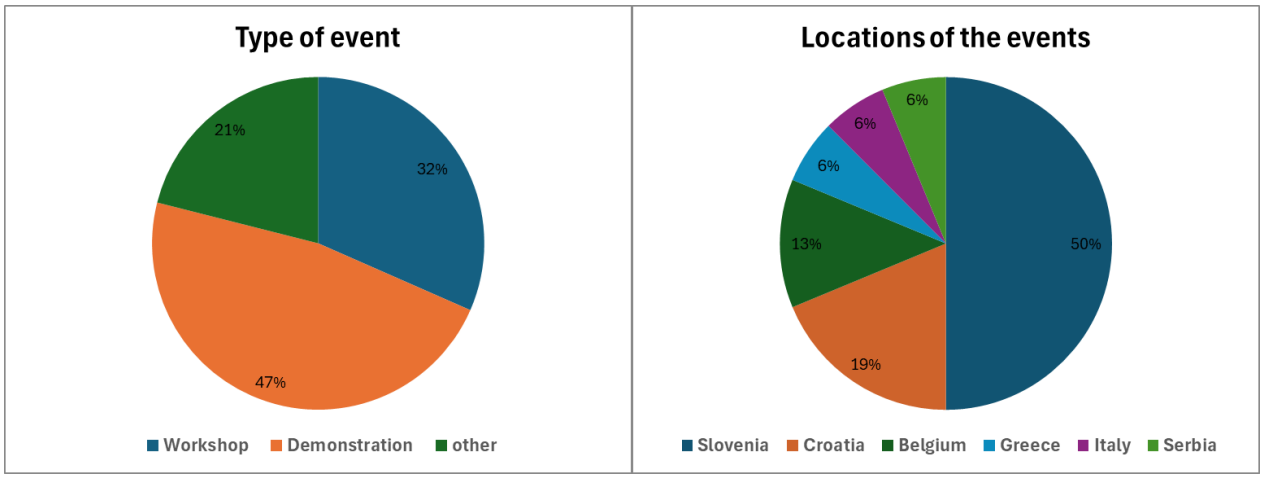

Figure 18: Graphical representation of the type of the event and locations of the events in the period of 2023-2025.

Zero-waste seaweed coating innovation main channel was workshop with 6 and demonstrations with 9 events with performed in altogether 6 counties (4 Mediterranean). REMEDIES partners involved in the activities supporting NIC were ANGR with the Greek event and EXIT as provider of the venues within their conferences and festival.

In the Table 12 an overview of the REMEDIES zero-waste seaweed coating demonstrations at specific event in the period of 2023-2025 with the specification of the country, reach and engaged individuals and described what was the citizen science-based methodology co-development. The more detailed description of the event with the listing of the stakeholders is done in the next sections. As a citizen science related outcome, a cocreation of the methodologies was followed and tested. The results of this process are represented in Chapter 6.

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Table 12: Overview of the activities to co-created citizen science demonstration toolkit for zero-waste cosmetics together with estimated people reached and engaged in the period of 2023-2025.

	Type of the event	Location (Country)	Reach (number of people)	Engagement (number of people)	Methodology co-development
1	Workshop	Slovenia	3000	50	Survey
2	Workshop	Slovenia	150	50	Interviews, video
3	Demonstration	Belgium	1000	200	Interviews, video
4	Workshop	Croatia	500	50	DIY guidelines, video, survey
5	Demonstration	Croatia	12000	150	Interviews, video
6	Workshop	Slovenia	25	25	Survey, Menti, video, DIY guidelines
7	Workshop	Slovenia	40	40	Menti, survey, DIY guidelines
8	Workshop	Slovenia	10000	500	Surveys, DIY guidelines
9	Presentation at trade fair	Greece	2000	50	Promo material, business opportunity
10	Presentation at trade fair	Slovenia	1500	30	Promo material, business opportunity
11	Presentation at trade fair	Serbia	1000	50	Promo material, business opportunity
12	Presentation at conference	Belgium	100	20	Pitch, survey
13	Presentation at conference	Croatia	500	150	Product placement
14	Demonstration	Slovenia	100	30	Product placement, Interviews, video
15	Presentation at fair	Italy	200	10	Promo material, business opportunity
16	Research student residencies	Slovenia	5	5	Survey, DIY guidelines
17	TV Show	Slovenia	300000	NA	Product placement, Interviews, video
18	TV Show	Slovenia	150000	NA	Product placement, Interviews, video
19	TV Show	Slovenia	50000	NA	Product placement, Interviews, video
Total (2023-2025)			532120	1410	

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5.2.1 REMEDIES zero-waste cosmetics workshops and demonstrations

Name of the event: Dan Evrope 2023 (Europe Day 2023)

Type of the event: Public event

Location: Ljubljana, Slovenia

Date of the event: 9.05.2023

Number of people attended/visited: 3000

Number of people engaged: 50

Number of shampoo balls made/distributed: 200

Stakeholders: children from local schools, general public, policy makers, zero-waste enthusiast, national and EU high level politicians

General information's about event and role of REMEDIES

The organizer - the European Commission Representation in Slovenia - focused on the themes of the green transition with the motto "Principles of Sustainability for the Europe of the Future." In collaboration with numerous partners, Europe Day presented to many visitors in a practical and fun way what changes we can make together in our daily lives and how the European Union supports the green transition through various programs and incentives.

The jury particularly highlighted the zero-waste design and execution of the event, the accessibility of the venue, and the inclusion of diverse organizations and people, including vulnerable groups in the program, as well as the media and digital communication support. The media partner was Val202. The event attracted 2,800 people, but despite its size and numerous activities, it generated only 24.4 kilograms of waste, 94 % of which was separately collected. All waste was carefully monitored, measured, and weighed by Ecologists Without Borders. This earned it the title of an event on the path to less waste.

REMEDIES partner National Institute of Chemistry of Slovenia participated at the Europe Day 2023 which have won Sustainable Events Awards 2024 in the category of large public events (over 1,000 participants) at the internal annual competition of the European Commission for the best sustainable events. This is an annual competition involving all departments of the European Commission. It is part of the European Commission's strategy to reduce the carbon footprint of its operations and to become climate-neutral by 2030. Among the various measures are more sustainable events and gatherings.

Dissemination material used to co-create the citizen science approach:

A poster, roll-up to demonstrate the activities at the stand was done. A feedback QR code with a zero-waste cosmetics survey and feedback on the workshops.

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Figure 19: Communication tool, citizen engagement and feedback collection details from the event (Photo: Uroš Novak)

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Figure 20: NIC team meeting with president of the Republic of Slovenia at the workshops (Photo: European Commission representation Slovenia)

Figure 21: Workshop area and briefing of the team before event starts (Photo: Uroš Novak)

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Figure 22: Produced zero-waste coating for shampoo and shower gels by workshop participants (Photo: Uroš Novak)

Figure 23: NIC team interaction with the participants (Photo: Uroš Novak)

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Figure 24: Award for best sustainable event 2024

The awarded Europe Day 2023 took place on May 9, 2023, at Congress Square in Ljubljana.

European Commission representative from Slovenia warmly thanked all partners, including the team of Scientists Against Plastic from the National Institute of Chemistry lead by Uroš Novak, the REMEDIES program coordinator, for accepting the challenge of an event on the path to zero waste. With their knowledge and creative approaches, they ensured that the initial idea grew and succeeded. The award for the best large sustainable public event in the European Commission is also an award for every one of you who co-created the event.

Name of the event: Čista obala event 2023 (Clean coast event 2023)

Type of the event: Public event

Date of the event: 11.09.2023

Location: Strunjan, Slovenia

Number of people attended/visited: 150

Number of people engaged: 50

Number of shampoo balls made/distributed: 500

Stakeholders: Participants in the cleanups, families with children, tourist, public, ecologist NGOs, influencers, local and regional authorities

General information's about event and role of REMEDIES

Clean Coast is a voluntary cleanup action for the entire Slovenian coast, taking place since 2008, organized jointly by the Tri-Niti Institute and the Ministry of Natural Resources and Space, Slovenia.

In 2023, the REMEDIES project, led by the National institute of Chemistry, has joined the event. At the joint meeting in Strunjan, one of the REMEDIES project stands will present zero-waste cosmetics production and demonstrate the operation of a handheld NIR device for detecting the type of plastic in collected waste. Overall, more than 130 participants joined the clean-up event and during the zero-waste

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workshop demonstration and since the location was in the park near the beach and the hotel additional participant showed interest.

Dissemination material uses to build the citizen science approach:

Poster representing the workshop promo Instagram video about the workshop and interviews with the workshop participants.

Figure 25: Location of the zero-waste cosmetics workshop in Strunjan as part of Čista obala event (Photo: Uroš Novak)

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Figure 26: Interactional activities with citizens towards plastic conscious society and zero-waste solutions (Photo: Uroš Novak)

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Name of the event: EU OCEAN DAYS 2024

Type of the event: With invitation only

Location: Brussels, Belgium

Date of the event: 5.03.2024

Number of people attended/visited: 1000

Number of people engaged: 200

Number of shampoo balls made/distributed: 300

Stakeholders: Policy makers, European commission, oceanpreneurs, NGOs, public, research project, scientists, journalists

General information's about event and role of REMEDIES

On March 5, 2024, the Mission "Restore our Ocean and Waters by 2030" Annual Forum convened leaders, experts, and advocates from around Europe, dedicated to the crucial task of safeguarding our oceans and water bodies. Among the prominent participants were the National Institute of Chemistry and Impact Hub Athens, representing the REMEDIES Program. Their involvement injected fresh perspectives and actionable insights into the ongoing dialogue on ocean conservation.

Throughout the forum, thought-provoking discussions resonated, highlighting key themes such as climate neutrality, circularity in the Blue Economy, and the imperative of sustainability. These discussions illuminated the intricate interplay between human activities and marine ecosystems, emphasizing the urgency of adopting holistic approaches to address environmental challenges.

The collaborative spirit permeating the forum was palpable, with participants exchanging ideas, best practices, and innovative solutions. This collective effort underscored the importance of forging partnerships across sectors and borders to tackle the complex issues facing our oceans. It reaffirmed the belief that by pooling resources, expertise, and knowledge, we can amplify our impact and drive positive change on a global scale.

Dissemination material used to co-create the citizen science approach:

Poster about zero-waste cosmetics, samples of the shampoo, Instagram video about the event, interviews about the product and its possible use from the EU mission ocean people

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Figure 27: Presentation of the zero-waste seaweed coating for cosmetics at the 2nd EU oceans days.

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Figure 28: Promotion of the zero-waste shampoo balls at the EU Ocean days annual forum to audience.

Figure 29: Showcasing the seaweed biomaterial as coating for zero-waste cosmetics solutions

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Name of the event: Zero-waste cosmetics workshops during SeaStar festival

Location: Umag, Croatia, public beach

Type of the event: Public event

Date of the events: 24.-25.5.2024

General information's about event and role of REMEDIES

Estimated number of people reached: 500

People participated: 50

Produced of shampoo balls: 1500

Stakeholders: public, tourist, influencers, entrepreneurs, young adults, families

In a vibrant celebration of sustainability and creativity, NIC hosted two workshops on zero-waste cosmetics as part of the EXIT SeaStar Festival 2024 in Umag, Croatia, on May 24 and 25. These workshops showcased REMEDIES' innovation in preventing single-use plastic packaging pollution through citizens' handmade do-it-yourself seaweed coating alternatives. This initiative aimed to educate and inspire the general public about the benefits and practices of a zero-waste, plastic-free lifestyle. Organized by REMEDIES partners NIC and EXIT, the workshops drew a remarkable turnout, with over 40 enthusiastic participants engaging in hands-on activities to create colourful zero-waste seaweed coatings for their shampoos. Moreover, more than 2,000 shampoo balls were made and handed out to the visitors of the SeaStar event. Discover more[44]

Dissemination material used to co-create the citizen science approach:

Posters and roll up that provide information to the public at the location, social media movies promoting the workshops shared by EXIT foundation and SeaStar music festival[45]. Free samples shared to the people on the public beach and hotel pool. The workshop was supported by live music from a DJ.

[44] https://www.youtube.com/watch?v=0r7OBPZhabI

https://www.instagram.com/p/C8B8vKVsbCc/?utm_source=ig_web_copy_link&igsh=MzRlODBiNWFlZA

https://www.instagram.com/p/C8HGlwFMVGK/?utm_source=ig_web_copy_link&igsh=MzRlODBiNWFlZA==

[45] https://www.seastarfestival.com/ accessed 10.12.2025

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Figure 30: Visual representation of the event dissemination at the Umag beach (photo: Mirta Cindrić)

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Figure 31: Engaged citizens in workshop (photo: Mirta Cindrić)

Figure 32: Detail on the zero-waste cosmetics involvement of the citizen (photo: Mirta Cindrić)

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Figure 33: Result of the citizen activities unique coloured zero-waste shampoo balls with seaweed coating (photo: Mirta Cindrić)

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Figure 34: Mentors and hostesses to support the workshop and promotion at the workshop (photo: Mirta Cindrić)

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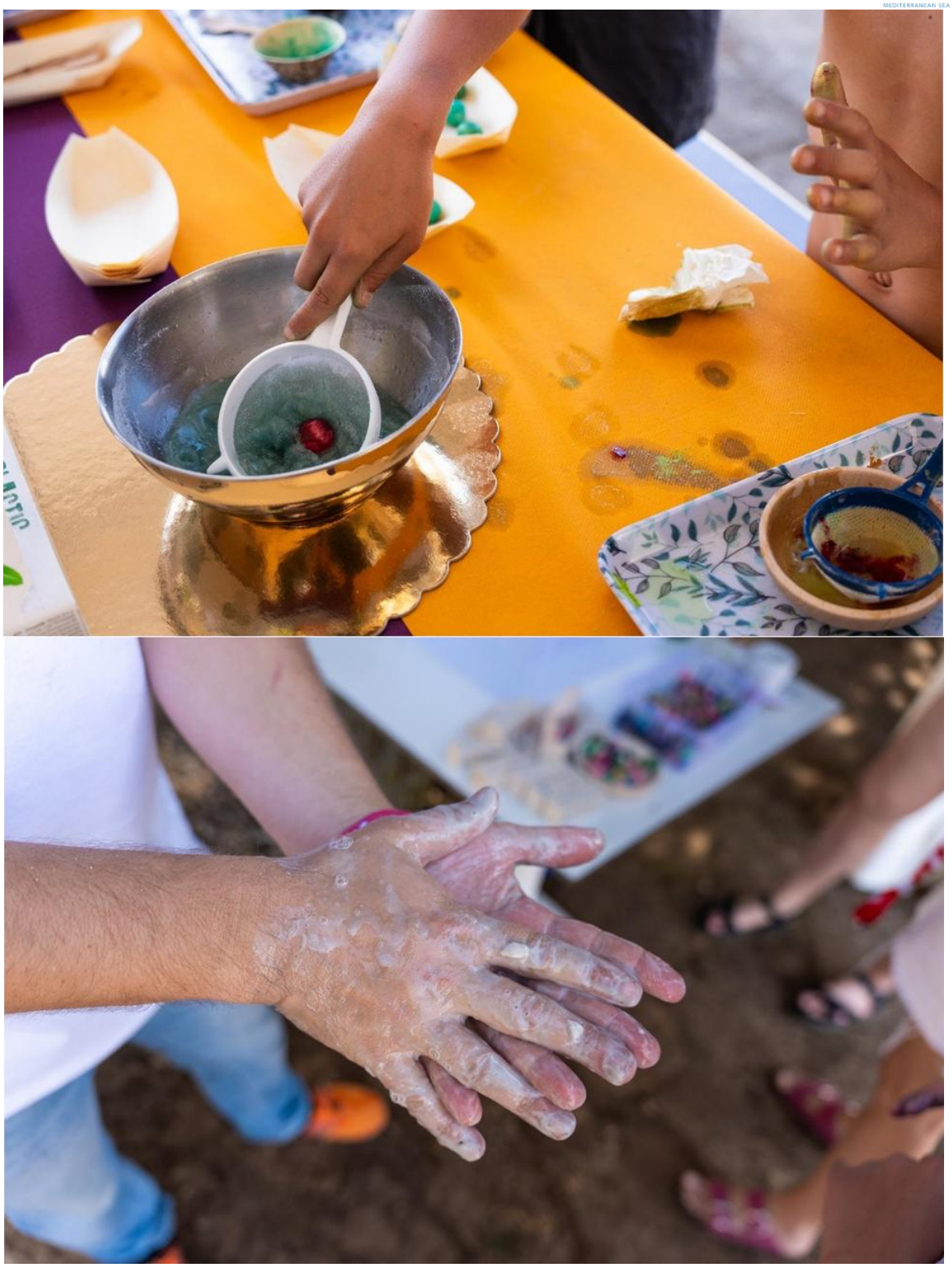

Figure 35: Detailed capture of the applying seaweed coating on the coloured shampoo ball and test of the product on site (photo: Mirta Cindrić)

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Name of the event: Zero-waste cosmetics promotion at SeaStar festival

Location: Stella Maris lagoon, City of Umag, Croatia

Type of the event: Festival

Date of the events: 24.-25.5.2024

Estimated number of people reached: 12.000

People participated/engaged: 150

Shared shampoo balls: 500

Stakeholders: public, tourist, influencers, entrepreneurs, young adults, festival organizers

General information's about event and role of REMEDIES

Since 2017, the best music festival in this part of Europe - Sea Star Festival puts Umag and Istria on the map of the world's most relevant festivals, bringing tens of thousands of young people from all over Europe to this region every year. This festival is also REMEDIES demo site[46]. With an attendance of 50.000 per festival edition. REMEDIES partners NIC were present at a stand inside the festival area that was operating to promote, educate and to share the samples to participants and collecting their feedback. Additionally, the media team prepared the promo video.

Dissemination material used to co-create the citizen science approach:

Promotional booth with free samples of shampoo and questionnaire on awareness about zero-waste, posters and roll up that provide information to the public at the location, social media movies promoting the workshops shared by EXIT foundation and Seastar[47]. Free zero-waste shampoo samples shared to the people at the festival.

[46] https://remedies-for-ocean.eu/sea-star-festival-umag-croatia/ (accessed 10.12.2025)

[47] https://youtube.com/playlist?list=PLvIb_uccCDPsmHxI4gvdRb4mFt6Mh5E9T&si=Kpp-1XpgQL08YkIx (accessed 10.12.2025)

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Figure 36: Sharing awareness about REMEDIES zero-waste cosmetics to festival participants at the booth. (Photo: EXIT)

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Name of the event: Zero-waste cosmetics workshop

Type of the event: Workshop Registration needed

Location: Astoria Hotel, Bled, Slovenia

Date of the event: 17.4.2025

Estimated number of people reached: 25

People participated: 25

Produced shampoo balls: 500

Stakeholders: engaged public, influencers, students, designers, cosmetics producers.

General information's about event and role of REMEDIES

A workshop was prepared in the collaboration with the CEFOODCYCLE project as part of the circular economy of unavoidable waste from the HORECA (Hotels, Restaurants, Catering) sector. The workshop was promoted a circular use of coffee grounds in the cosmetics applications. NIC team prepared a full workshop showing zero-waste cosmetics with the seaweed coating with the coffee grounds as a peeling component to be added.

Dissemination material used to co-create the citizen science approach:

Intro to the workshop presentation using Mentimeter[48], roll up, poster, social media flyers for promotion of the event, workshop video[49] and picture material, surveys on the pre-existing knowledge and on the workshop experience, presentation of the step-by-step guidance.

Figure 37: Intro to zero-waste cosmetics workshop (Photo: Sara Rman)

[48] https://www.mentimeter.com/ (accessed 1.12.2025)
[49] https://www.youtube.com/watch?v=K7OnRbKKtA4 (accessed 10.12.2025)

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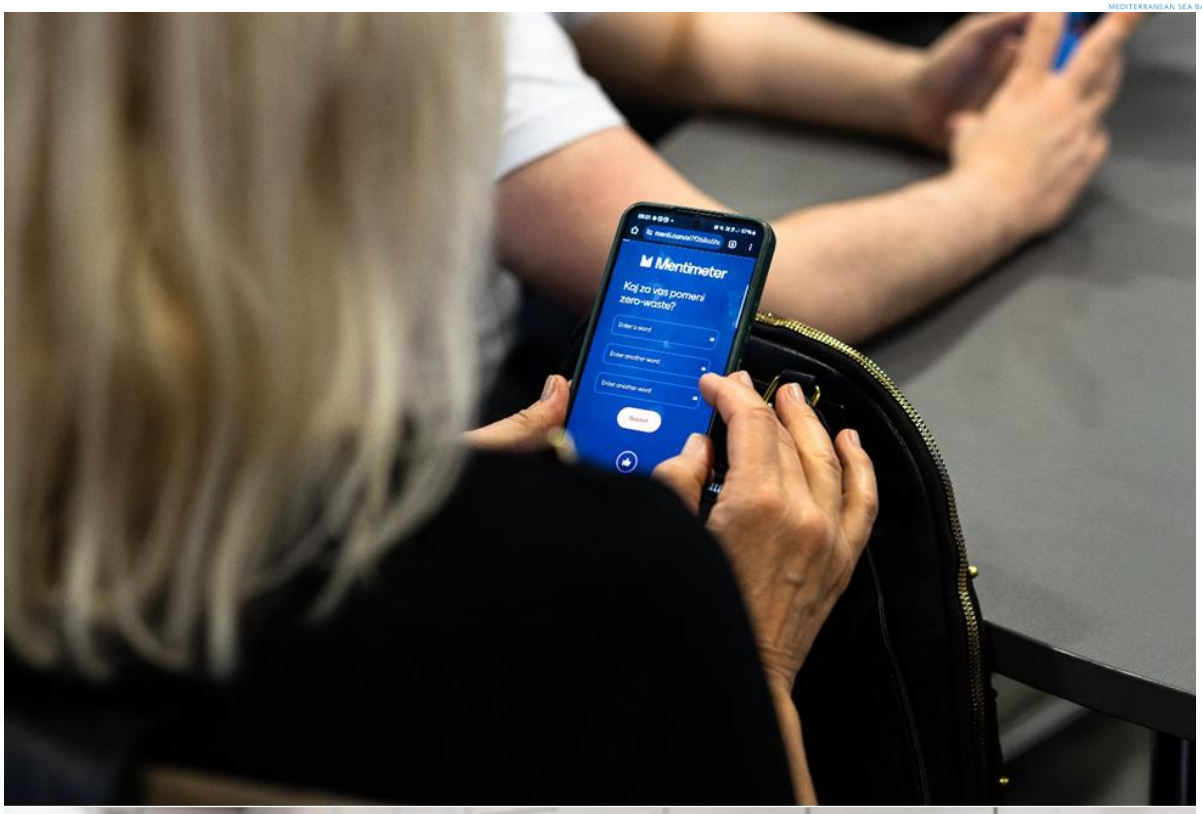

Figure 38: Surveying the workshop participant via Mentimeter and the prepared workstation for each participant. (Photo: Sara Rman)

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Figure 39: Step by step instruction on zero-waste cosmetics preparation and execution step from the participants. (Photo: Sara Rman)

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Figure 40: Final product selection of secondary packaging for transport and home use (Photo: Sara Rman)

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Name of the event: Discover EU: Microplastics: The Invisible Impact in Everyday Life

Type of the event: Workhops, registration needed

Location: Astoria Hotel, Bled, Slovenia

Date of the event: 24.4.2025

Estimated number of people reached: 40

People participated: 40

Produced shampoo balls: 400

Stakeholders: engaged public, influencers, students, designers, cosmetics producers, senior citizens.

Plastic accompanies us at every step, even where we least expect it - in water, food, air, and even cosmetics. But what do we really know about microplastics, and what can we do to avoid their harmful effects? In the first part, Andreja Palatinus, BA in Ecology and MP, attorney at law, a expert from NIC independent entrepreneur and initiator of the Clean Coast initiative, the Adriatic Microplastics Research Community, and the "Microplastics for Breakfast" events, will explain how microplastics are formed, how they spread in our environment, where they have already been found, and how to combat the generation and exposure of microplastics in our lives. She will also introduce EU initiatives in this area. We will be joined by Nika Veger, author of the sustainable blog Beautyfull Blog and ambassador of the European Climate Pact. In the second part, under the guidance NIC and the European project REMEDIES, we will roll up our sleeves and make single-use shampoo balls without waste. This is an innovative and sustainable solution that does not

Figure 41: Making of zero-waste shampoo balls and coating of the shampoo by workshop participants (photos: print screen from @evropska komisija Instagram post)

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contain microplastics. We will be able to make balls in different colors and scents and contribute to a cleaner environment and a more sustainable lifestyle.

Figure 42: Workshop participants following DIY guidelines on how to make a zero-waste shampoo ((photos: print screen from @evropska komisija Instagram post)

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Name of the event: Znanstival 2025 (Science fair)

Type of the event: Public event

Location: Ljubljana, Slovenia

Date of the event: 30.5-1.6.2025

General information's about event and role of REMEDIES

Estimated number of people reached: 10.000

People participated: 500

Downloads of the DIY guidelines: 107

Completed surveys: 15

Produced of shampoo balls: 1500

Stakeholders: public, tourist, influencers, entrepreneurs, young adults, schoolchildren

The traditional three-day festival is dedicated to encouraging curiosity and creativity, as well as promoting education and science. It takes place on the streets, bridges, and squares of Ljubljana, and of course, in the House of Experiments. Znanstival is a festival of adventures, scientific lectures, experimental workshops, "The Experience," the Garden of Experiments, and the Little House of Experiments, and is intended for all ages and genders. The only condition for participation is curiosity. The festival is free for visitors. This time The National Institute of Chemistry as a scientifically excellent, established and breakthrough research institution in the European area. With our top-level research, we enrich the global treasury of knowledge, focusing on solving pressing societal challenges such as climate change, health and the circular economy performed a citizen science and educational activities on the zero-waste cosmetic.

The participants were able to make your own zero-waste shampoo, where we present how-to make these innovative products, such as shampoo wrapped in a coating made from algal biopolymers and pigments, which represents an alternative solution to single-use plastic packaging. Visitors were able to learn first-hand about zero-waste shampoo balls and take some with them; through a open access to do-it-yourself process tutorial, they can make their own unique shampoo balls in different colours and scents also by themselves.

Dissemination material used to co-create the citizen science approach:

Posters, survey for participants and do it yourself guidelines for zero-waste cosmetics, samples of the products for later use

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Figure 43: Science fair with zero-waste shampoo balls preparation workshops (Photo: Uroš Novak)

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Figure 44: Participants in the creation of zero-waste seaweed coating shampoos showing their product (Photo: Uroš Novak)

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5.3 Presentation of REMEDIES zero-waste cosmetics on business fairs and conferences

Name of the event: GREEN EXPO 2023

Type of the event: Fair

Location: Athens, Greece

Date of the event: 3.11.2025

Estimated number of people reached: 2000

People engaged: 50

Stakeholders: public, policy makers, entrepreneurs, environmental NGO, local authorities

Alchemia Nova Greece (ANGR) was a proud exhibitor at the first Forward Green Expo (FG-Expo) held in Thessaloniki 8th to 10th June 2023. The aim of the FG-Expo initiative was to pave the way for cultivating a new entrepreneurial mentality in Greece, based on circular economy, green development, and business model transformation. ANGR team, including Polymnia Dagtzidou, Johannes Kisser and Maria Troullou, created an inspiring lighthub demostrating the company's innovative approach to sustainability.

Different audiences were engaged, and fruitful discussions emerged at the specially designed Horizon Europe info-stands dedicated to the holistic systemic approaches to municipal wastewater treatment and reuse within project HYDROUSA and zero-waste cosmetics at project REMEDIES.

Figure 45: ANGR team presenting zero-waste cosmetics at a green expo fair (Photo: ANGR archive)

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Name of the event: MOS 2023

Type of the event: Public event

Location: Celje, Slovenia

Date of the event: 3.11.2025

Estimated number of people reached: 1500

People engaged: 30

Stakeholders: public, policy makers, entrepreneurs, environmental NGO, local authorities

MOS remains the largest business and trade fair event in the region, attracting more than 50,000 visitors and 650 exhibitors from 20 countries each year. With its new vision, MOS 2026 defines itself even more clearly - as a hub of innovation, sustainable construction, and entrepreneurship.

At Celje Fair's exhibition hall, the 55th MOS fair took place from September 13 to 17, during which the "Nexus of Science and Economy" once again successfully presented itself. The Nexus is a project of the Ministry of Higher Education, Science and Innovation, and among more than 30 participating faculties, institutes, centers of excellence, and high-tech companies that jointly presented over a hundred innovations, this year also featured the REMEDIES innovation showcasing zero-waste coatings for cosmetics.

Figure 46: Display of zero-waste cosmetics and the brief description about the solution and the REMEDIES project (Photo: Mirica Karlovits)

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Name of the event: "Beyond Plastic Waste: Are We Ready to Do Our Bit

Type of the event: Conference and fair

Location: Novi Sad, Serbia

Date of the event: 4.10.2024

Estimated number of people reached: 1000

People engaged: 50

Stakeholders: public, entrepreneurs, environmental NGO, local authorities

The conference entitled "Beyond Plastic Waste: Are We Ready to Do Our Bit?", was held on Friday, 4 October at the Novi Sad Fair of Ecology under the auspices of the REMEDIES Project, supported by the European Union through the HORIZON programme. REMEDIES coordinator gave a welcome speech and presented the innovations form the project in a dedicated roundtable. Beside the conference zero-waste shampoo balls were presented in the Novi sad fair of ecology. Discover more about the conference in the link[50] and check the full conference recordings[51].

Figure 47: Demonstration of the zero-waste shampoo at the booth (Photo Uroš Novak)

[50] https://www.exitfest.org/en/the-first-remedies-conference-of-exit-foundation-joining-forces-and-a-multidisciplinary-approach-toward-a-greener-festival-industry (Accessed 1.12.2025)

[51] https://www.youtube.com/watch?v=mfwP4hKAMmo (Accessed 1.12.2025)

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Name of the event: EU OCEAN DAYS 2025

Type of the event: Public event with registration

Location: Brussels, Belgium

Date of the event: 5.3.2025

Estimated number of people reached: 100

People engaged: 20

Stakeholders: EU project, European commission, public, entrepreneurs, environmental NGO, local and regional authorities, start-ups

General information's about event and role of REMEDIES

4th Mission Ocean and Waters Forum The fourth Annual Forum of the Mission "Restore our Ocean and Waters" aims at taking stock of the Mission's progress and major achievements, at mobilising relevant actors around key Mission deliverables for the deployment phase. The event will showcase innovative solutions developed under the Mission, discuss how key stakeholders, such as the regions, local authorities and the private sectors are involved in implementing the Mission and how different streams of finance are being mobilised to support the scaling and deployment of solutions for reaching the Mission objectives: to protect and restore marine and freshwater ecosystems and biodiversity, boost coastal resilience, eliminate pollution, and make the blue economy climate-neutral and circular. Following the assessment of the Mission, the event will be an opportunity to discuss the strategic focus of the Mission in the years to come and the necessary steps forward. Uroš Novak presented in a special session 90 s pitch entitled Eco-conscious travel: Embrace zero-waste cosmetics for a greener journey.

Figure 48: Capture from the pitch on zero-waste cosmetics with as a seaweed innovation by Uroš Novak at the EU ocean days 2025 (photo Sylvain Petit)

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Name of the event: 1st BRIDGE CONFERENCE

Type of the event: Conference

Location: Savudria, Croatia

Date of the event: 3.11.2025

Estimated number of people reached: 500

People engaged: 150

Stakeholders: EU project, European commission, public, entrepreneurs, environmental NGO, local and regional authorities, start-ups

General information's about event and role of REMEDIES

The Bridge Conference took place in Umag from May 20 to 22, bringing together experts from the music industry, artists, producers, managers, and everyone involved in music and cultural production. By uniting promoters, artists, managers and agents with tech leaders, Bridge will showcase how cutting-edge innovations—like AI, blockchain, Web3, VR and others - can bring immense new value to the music industry. REMEDIES partner National Institute of Chemistry prepared zero-waste cosmetics promotion package of shampoo balls for each registered participant and promoted zero-waste solution at the bridge festival in the roundtable.

For more details on the zero-waste cosmetics at the conference check the promo videos[52],[53] of the conference or the news[54].

Figure 49: Showcasing the zero-waste shampoo samples that were shared with all their participant of the conference as a promotional material (Photo: Uroš Novak & EXIT)

[52] https://www.youtube.com/watch?v=6a2JgK2MN8U (Accessed 1.12.2025)

[53]https://www.instagram.com/reel/DLj9TjqMiAn/?utm_source=ig_web_copy_link&igsh=MzRlODBiNWFlZA== (Accessed 1.12.2025)

[54] https://remedies-for-ocean.eu/remedies-at-the-bridge-conference-greening-festivals-for-a-circular-future/ (Accessed 1.12.2025)

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Name of the event: CIRCULAR SHIFT 2025

Type of the event: Conference and exhibition

Location: Bled, Slovenia

Date of the event: 25.10.2025

Estimated number of people reached: 100

People engaged: 30

Stakeholders: EU project, public, entrepreneurs, environmental NGO, local and regional authorities, start-ups, policy makers

Zero-waste cosmetics solutions from the REMEDIES project were featured at Circular Shift: From Waste to Value - Building the Circular Economy Together, hosted in Bled by the National Institute of Chemistry (NIC). The NIC presented the Zero-Waste Seaweed Coatings for Cosmetics, a result of a citizen-participation workshop conducted at a hotel. The technology uses a seaweed-based biopolymer to form a protective coating around cosmetic products; it dissolves in water, offering a biodegradable, zero-waste alternative to traditional packaging. This supports the shift toward plastic-free, circular product design in cosmetics, hospitality, and travel, where small plastic containers are widely used, aligning with REMEDIES' mission to prevent plastic pollution and promote market-ready innovations. To engage the audience, NIC set up a demonstration booth where participants could test and take home zero-waste cosmetics and receive a hand massage. The interactive display showcased the practicality and potential of seaweed-based coatings as biodegradable, circular alternatives to conventional packaging. The Bled presentation illustrated how innovative materials and circular design can significantly reduce waste in high-consumption sectors like cosmetics and hospitality, contributing to a plastic-free future in line with REMEDIES' goals.

Figure 50: Presentation of the zero-waste cosmetics (shampoo and peeling) and testing the peeling with hand massage to visitors at the exhibition place (Photo: Uroš Novak)

Co-funded by the European Union

Name of the event: ECOMONDO 2025

Type of the event: Public event as part of ECOMONDO fair

Location: Rimini, Italy

Date of the event: 3.11.2025

Estimated number of people reached: 200

People engaged: 10

Stakeholders: EU project, European commission, public, entrepreneurs, environmental NGO, local and regional authorities, start-ups

General information's about event and role of REMEDIES

REMEDIES project partners took part in the Mediterranean Lighthouse Bootcamp, which was held from 4 to 7 November 2025 at the Ecomondo Exhibition in Rimini, Italy. Organized by the BlueMissionMed CSA[55] in collaboration with the European Commission and the Ecomondo Scientific Technical Committee, the Bootcamp is the annual gathering of Mission-funded projects, Charter signatories, and Mediterranean stakeholders. Throughout the week, the programme will highlight the strategic role of the Mediterranean Lighthouse in advancing the EU Mission "Restore our Ocean and Waters by 2030"[56].

The Bootcamp featured high-level events, thematic sessions, roundtables, showcases, and networking opportunities, all designed to:

- Showcase innovative solutions and Mission results,
- Share knowledge and lessons learned,
- Foster collaboration among Mediterranean actors,
- Build pathways for scaling up and replication across the region.

As part of the CSA Blue Mission Med collaboration with ECOMONDO, selected solutions from the Mediterranean Lighthouse such as REMEDIES solution for zero-waste cosmetics were selected to pitch during the event.

[55] https://bluemissionmed.eu/

[56] https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/restore-our-ocean-and-waters_en

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Figure 51: Vesna Kuralt from NIC is pitching the zero-waste seaweed coating solutions for cosmetics at the Blue Mission Med event. (Photo: Vesna Kuralt archive)

Figure 52: REMEDIES plastic prevention solutions like zero-waste cosmetics showcased in ECOMONDO. (Photo: Vesna Kuralt archive)

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5.4. International student's residencies

From 2023-2025 NIC, research group lead for Bioplastics, biocomposites and zero-waste technologies[57] hosted 5 international students from Spain, Kosovo, Portugal, Romania and Czech Republic to work on the coating development processes and zero-waste cosmetics storage testing. Their main research focus was to simulate the citizen science demonstrative workshop and work on the most suitable recipes for coatings to be supported by difference shampoo brands. All the student's residencies were part of the Student Exchange Programme (SEP) within IPSF is a program of international professional practice for pharmacy students and related fields. The duration of their residency was between 1 weak to 1 month. All students worked on the direct mentorship of Dr. Uroš Novak and disseminate their results at the events organized by NIC.

Figure 53: Representation of the exchange students work from coatings processes optimization to storage environments. (Photo: Uroš Novak)

[57] https://www.ki.si/en/departments/d13-department-of-catalysis-and-chemical-reaction-engineering/research-fields-1/ (accessed 15.12.2025)

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Figure 54: Students at work and presenting the results to stakeholders. (Photo: Uroš Novak)

5.5. TV shows

Present in leading TV media in Slovenia promoting biomaterials and citizen science activities.

Uroš Novak was part of the 3 TV shows on RTVSLO one is explain scientific behinds of biomaterials and innovations at the TV Shows dedicated to science (Ugriznimo Znanost[58]) where he also demonstrated in practical way a seaweed coating is made. He also participated in very popular kids show Firbcologi[59], where with the help of the primary school students prepared a seaweed-based bubble tea, additionally zero-waste cosmetics were part of the POP TV inspector[60] piece where a demonstration of the seaweed coatings on the cosmetics were presented recently. Altogether this reached more than half a million viewers combined on TV or from social media show archives.

[58] https://365.rtvslo.si/arhiv/ugriznimo-znanost/174945215 (in Slovene language) (Accessed 1.12.2025)
[59] https://www.youtube.com/watch?v=8mYIv04Y-Qo (in Slovene language) (Accessed 1.12.2025)
[60] https://www.instagram.com/reel/DR7CKPCiGUp/?utm_source=ig_web_copy_link&igsh=MzRlODBiNWFlZA== (Accessed 1.12.2025)

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Chapter 6: Zero-waste cosmetic citizen science result

This chapter presents a collection of methodology developed through the co-creation process and experiences from activities described in previous Chapters, summarized in Table 10. Overall, over 500.000 people were reached, with more than 1.400 directly engaging with us, giving this innovation a sufficient level of engagement to be accepted and further promoted on a people-oriented basis via citizen science demonstration activities, that can be performed by both individuals and organizations, since all the information needed are available as open access in this deliverable. Overall, 6 countries (Slovenia, Belgium, Croatia, Greece, Serbia and Italy) were part of the zero-waste seaweed coating workshop or promo location with a total of 19 events held between 2023 and 2025.

6.1. Safety & ethical considerations

Consent and data privacy procedures should be implemented where necessary, ensuring compliance with relevant ethical and data protection standards.

When videos or photos are collected for public dissemination, reporting, or promotional purposes, a consent form must be prepared and signed by all workshop participants to protect their rights and comply with GDPR requirements.

A mandatory safety briefing must be conducted prior to the operation of the ball machine and any other tools or equipment used during the workshop.

Presentation materials will be designed to be inclusive and accessible, taking into consideration the needs of vulnerable groups such as individuals with epilepsy, dyslexia, or other specific conditions.

6.2. Open access strategies

All the material shared in the Chapter 6 is available under the CC-BY-SA Creative Commons Public Licence (Figure 55).

Creative Commons public licences provide a standard set of terms and conditions that creators and other rights holders may use to share original works of authorship and other material subject to copyright and certain other rights specified in the public licence below. The following considerations are for informational purposes only, are not exhaustive, and do not form part of our licences.

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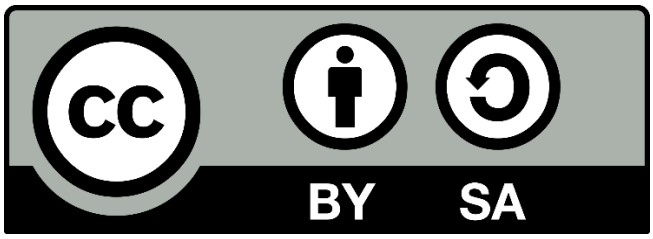

Figure 55: Attribution-Share Alike Creative commons licence (Photo: online[61])

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6.3. Communication flyers and poster about the zero-waste cosmetics workshops

The main communication elements at the event that are open to everyone without prior registration, are posters and leaflets that clearly demonstrate the message of what a zero-waste represents and what can be expected when joining and participating in the activities.

[61] https://creativecommons.org/share-your-work/cclicenses/ (accessed 1.12.2025)

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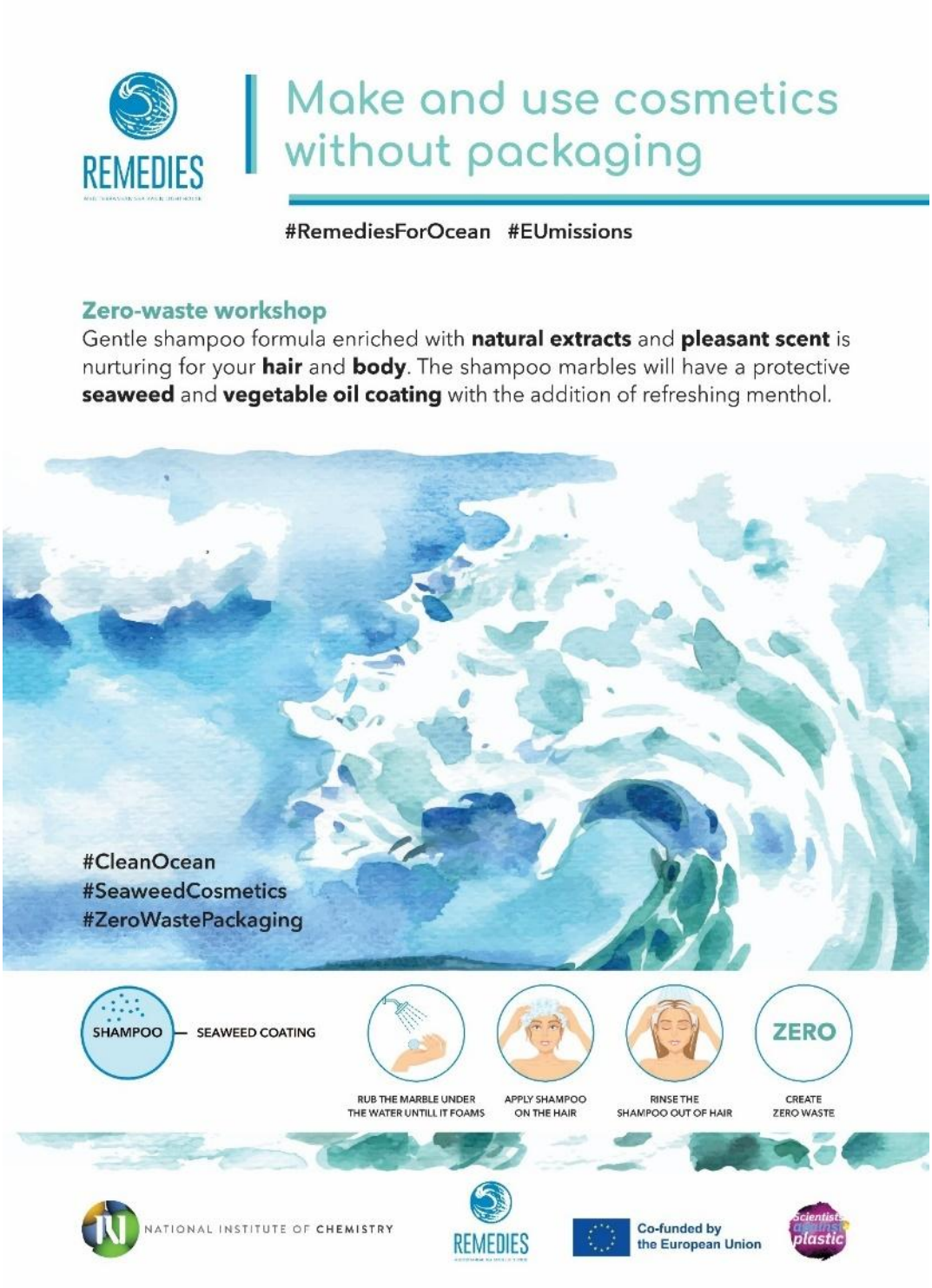
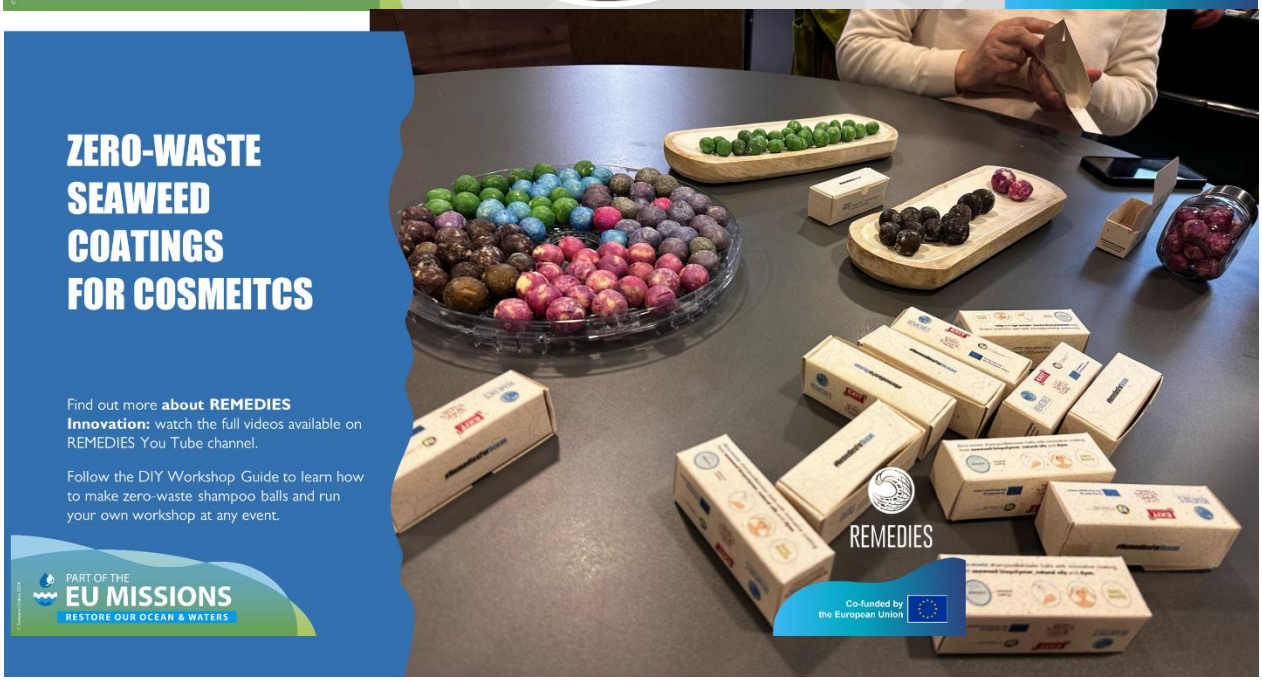


Figure 56: Poster presenting the zero-waste workshop (Author: Mirica Karlovits, NIC)


REMEDIES
ZERO-WASTE SEAWEED COATINGS FOR COSMETICS
PART OF THE
EU MISSIONS
RESTORE OUR OCEAN & WATERS
Co-funded by
the European Union


REMEDIES
ZERO-WASTE
seaweed coatings for cosmetics
PART OF THE
EU MISSIONS
RESTORE OUR OCEAN & WATERS
Co-funded by
the European Union


Become part of the zero-waste community!
PART OF THE
EU MISSIONS
RESTORE OUR OCEAN & WATERS
REMEDIES
Co-funded by the European Union


ZERO-WASTE SEAWEED COATINGS FOR COSMEITCS
Find out more about REMEDIES Innovation: watch the full videos available on REMEDIES You Tube channel.
Follow the DIY Workshop Guide to learn how to make zero-waste shampoo balls and run your own workshop at any event.
PART OF THE
EU MISSIONS
RESTORE OUR OCEAN & WATERS
REMEDIES
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Figures 57-61: Leaflets about the zero-waste demonstrative solutions for cosmetics (Author: Mirica Karlovits, NIC)

6.4. Instruction for do-it-yourself guidelines for zero-waste cosmetics with seaweed coatings

In this section a prepared step by step guidelines that are freely available and can be employed as part of the workshop as suggested in Section 6.5 or used primary by educational or capacity building activity on the level of individual, families or educational or NGO activities. For professionals in cosmetics and packaging sectors with the intended commercial use this guide is not seen as a direct solution to the market and before the commercialization proper certification should be done.

There are three variations of the zero-waste cosmetics with seaweed coatings presented. In Figures 62-112 a step-by-step explanations step with the link to ingredients and equipment needed are presented.

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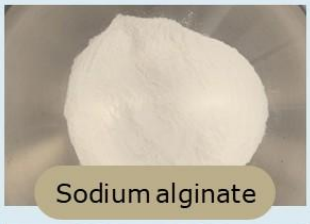
Do it yourself!
Zero-Waste
Seaweed Coatings for Cosmetics
SHARE THIS GUIDELINE!
PART OF THE
EU MISSIONS
RESTORE OUR OCEAN & WATERS
Co-funded by the European Union
Scientists against plastic
REMEDIES
NATIONAL INSTITUTE OF CHEMISTRY
Equipment and accessories
shampoo balls MACHINE
approx. 250 balls
45 min
1 large metal bowl
2 small metal bowls
1 wooden bowl
1 spoon
2 small sieves
1 tray
Balls making machine
Dehydrator/dryer
Handheld stick blender

Ingredients

Tapioca starch
Stearic acid
Sodium alginate
Ethanol
Water (aqua)
Dehydrated liquid shampoo
Calcium Chloride
Menthol


Tapioca starch


Stearic acid

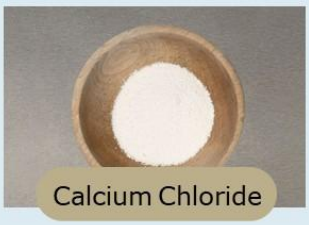

Sodium alginate


Ethanol


Water


Dehydrated liquid shampoo

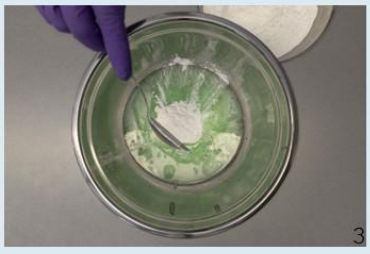

Menthol


Calcium Chloride

Mixing of the shampoo dough


1

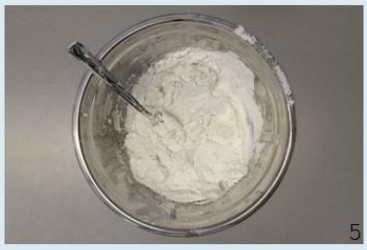

2


3

1 750 g of dehydrated shampoo (water content below 40%).

2 Mix 500 g of Tapioca starch.

3 Add mixed powders to shampoo; approx. 1/3 of at the time.



4-6 First, mix the ingredients with a spoon, then knead with your hands.

7 The shampoo dough is ready when it no longer sticks to your hands or the bowl.

Making of shampoo balls via balls machine

Machine

8-10 Take approx. 30g of the dough and roll it into a 30cm-long shape with a diameter of about 2 cm.

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11


12


13

11-13 Add some tapioca starch to the ball machine, then place the 30 cm shampoo dough inside. Gently press the dough to position it in place.


14


15

14-15 Turn the lever clockwise until all the shampoo balls drop out to the tray below.

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Preparing coating solution 1

Hand Blender

Sodium alginate
20 g

16

Tapioca starch
5 g

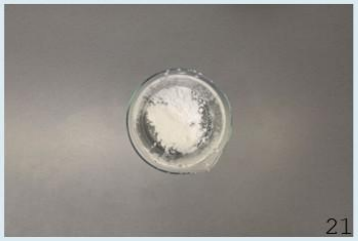
17

Water
500 ml

18

19

20



21

19-21 Add sodium alginate and tapioca starch to the water.

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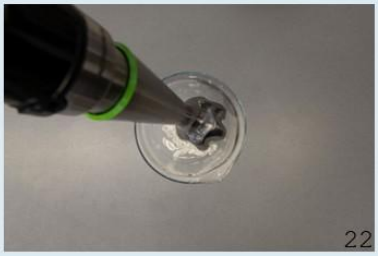
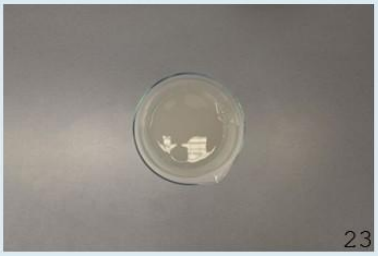
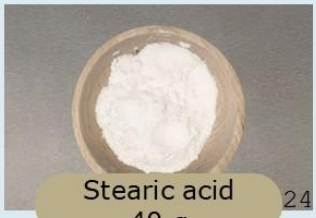

22

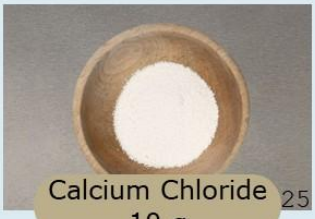

23

22 Blend until fully dissolved (approximately 3 minutes).

23 Coating solution 1.

Preparing coating solution 2


Stearic acid 40 g 24


Calcium Chloride 10 g 25


Menthol 1 g 26


Water 300 g 27


96% Ethanol 700 g 28

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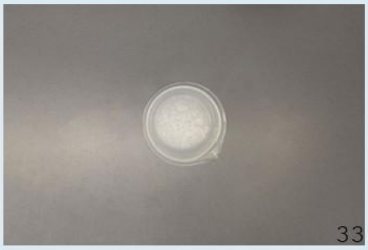
Preparing coating solution 2

29–31 Add all ingredients into one beaker.



32 Blend until fully dissolved.

33 Coating solution 2.

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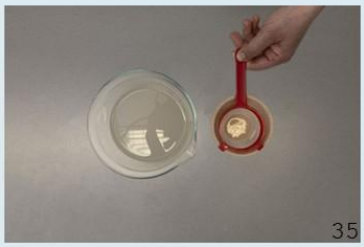
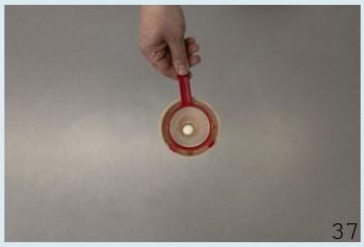
Coating the shampoo balls



34 Add 3 tablespoons of Coating Solution 1 to a small wooden bowl.



35–37 Wet the sieve with Coating Solution 1, then add the shampoo balls.

38 Prepare a larger bowl with Coating Solution 2.

39–40 Swirl the shampoo balls in the sieve to achieve a glossy finish, then transfer them to the bowl with Coating Solution 2. Let them sit for at least 10 seconds.

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Dehydrator-Dryer


41


42


43

41 Use another sieve to pick up the coated shampoo balls.

42 Place the shampoo balls in a container to dry for a few minutes.

43 As a final step, use an oven at 45°C with ventilation mode for 15 minutes.

Optional:

Repeat steps 33-40 multiple times for a thicker coating.

Zero-Waste Packaging Options


44


45


46

44 Refillable container – for home use.

45 Shelf storage without packaging – a minimal-waste option.

46 Paper box – ideal for travel.

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Figures 62-78: Overview of the steps by step guidance in demonstration of the seaweed zero-waste cosmetics with the selected option to use balls machine (Authors: Tamara Bizjak, Dajana Jeglič, Uroš Novak).

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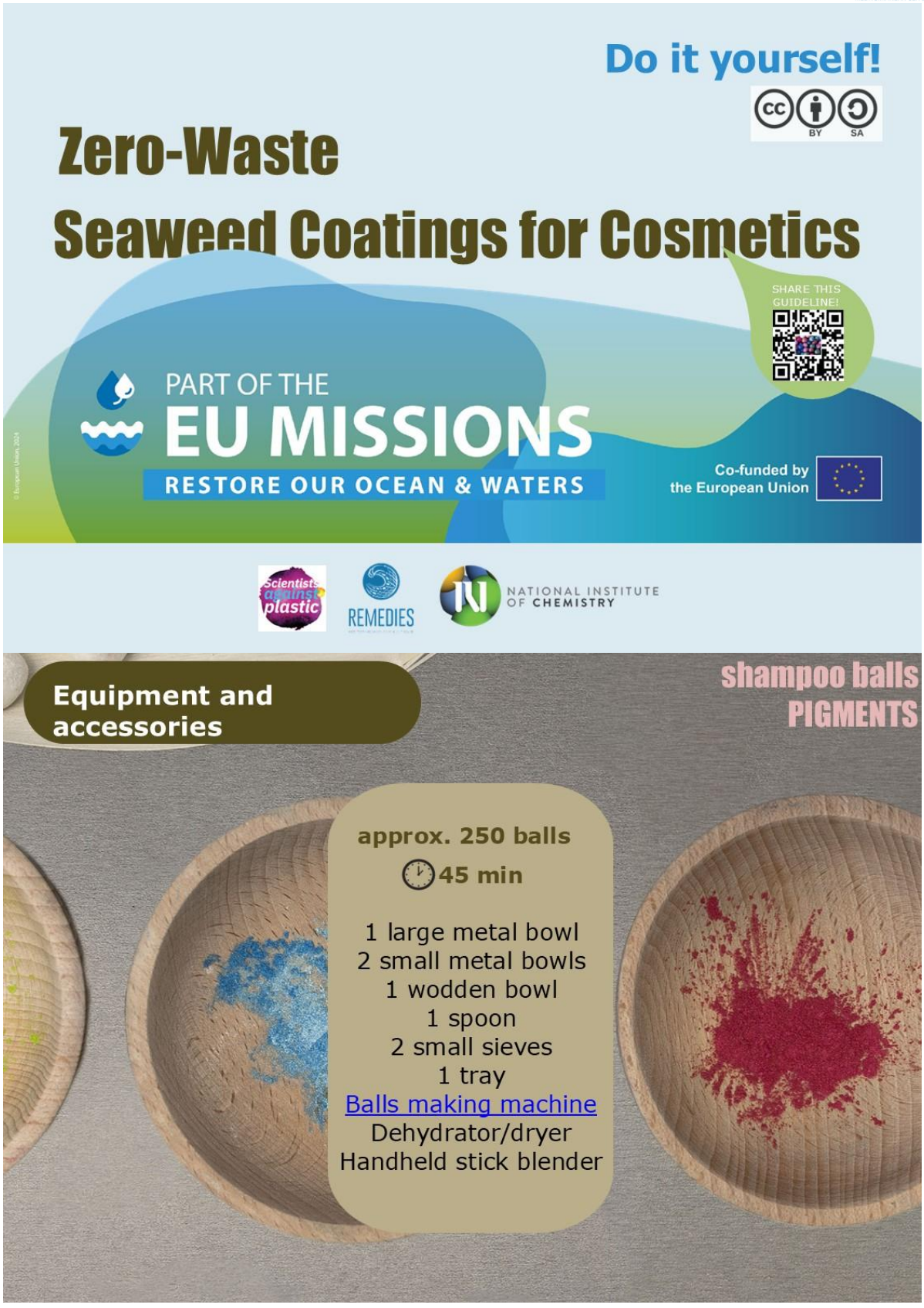

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Ingredients

Tapioca starch
Stearic acid
Sodium alginate
Ethanol
Water (aqua)
Calcium Chloride
Menthol
Pigments

Mixing of the shampoo dough

1 750 g of dehydrated shampoo (water content below 40%).

2 Mix 500 g of Tapioca starch.

3 Add mixed powders to shampoo; approx. 1/3 of at the time.

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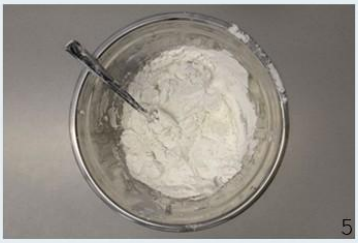
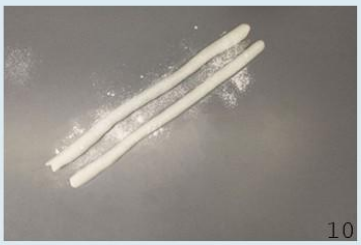


4–6 First, mix the ingredients with a spoon, then knead with your hands.

7 The shampoo dough is ready when it no longer sticks to your hands or the bowl.

Making of shampoo balls via balls machine

Machine



8–10 Take approx. 30g of the dough and roll it into a 30cm-long shape with a diameter of about 2 cm.

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11-13 Add some tapioca starch to the ball machine, then place the 30 cm shampoo dough inside. Gently press the dough to position it in place.

14-15 Turn the lever clockwise until all the shampoo balls drop out to the tray below.

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Preparing coating solution 1

Hand Blender

Sodium alginate
20 g

16

Tapioca starch
5 g

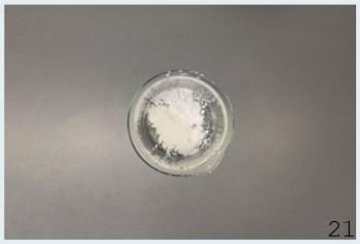
17

Water
500 ml

18

19

20



21

19-21 Add sodium alginate and tapioca starch to the water.

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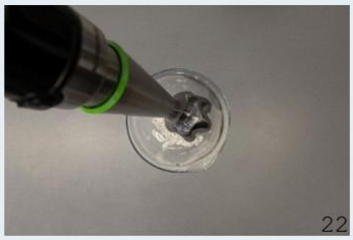
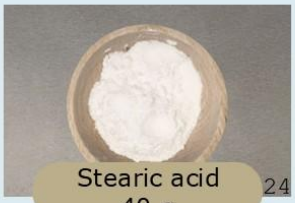
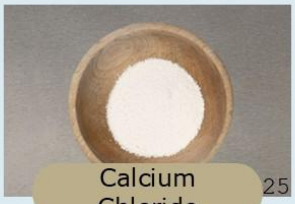


22 Blend until fully dissolved (approximately 3 minutes).

23 Coating solution 1.

Preparing coating solution 2





10

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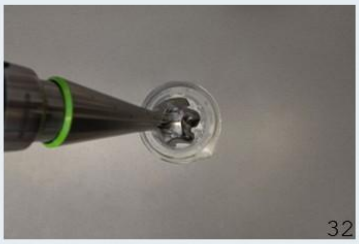
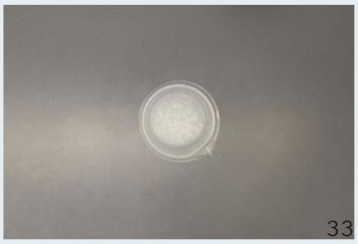
Preparing coating solution 2

29–31 Add all ingredients into one beaker.





32 Blend until fully dissolved.

33 Coating solution 2.

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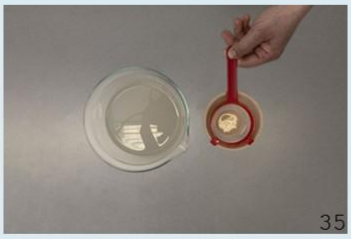
Coating the shampoo balls with pigments



34 Add 3 tablespoons of Coating Solution 1 to a small wooden bowl.

35-37 Wet the sieve with Coating Solution 1, then add the shampoo balls.

41-42 You can repeat the steps 38-40 for multiple pigments.

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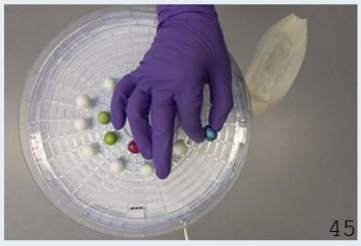
43-44 Using wooden spoon gently place ball into coating solution 2. Take it out with sieve after at least 15 seconds.



45-46 Place the coated shampoo balls on a dehydrador/dryer and dry them for 30 minutes at 35°C.

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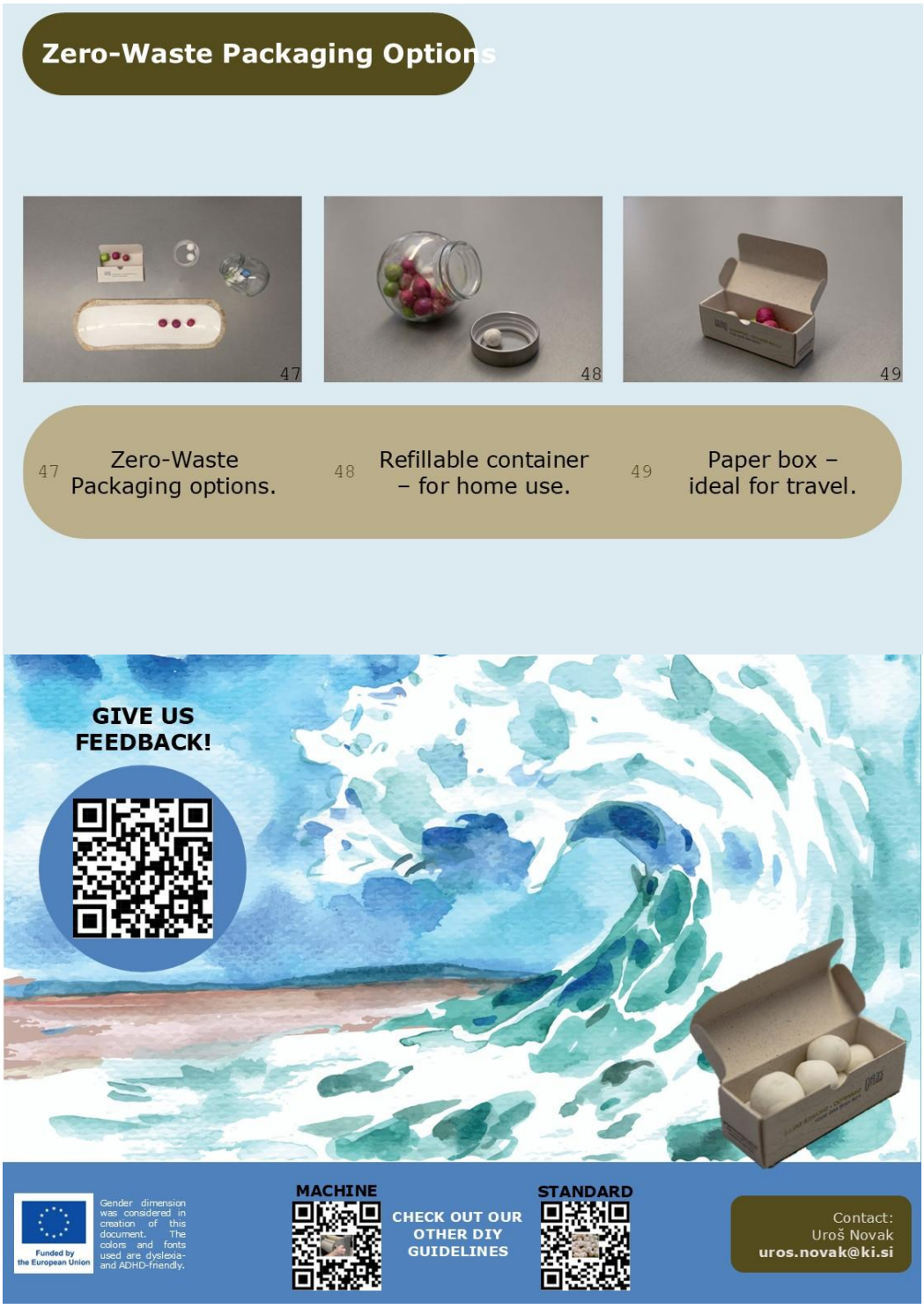

Figures 79-96: Overview of the steps by step guidance in demonstration of the seaweed zero-waste cosmetics with the selected option to use pigments (Authors: Tamara Bizjak, Dajana Jeglič, Uroš Novak).

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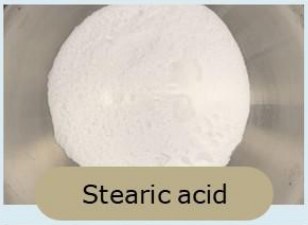
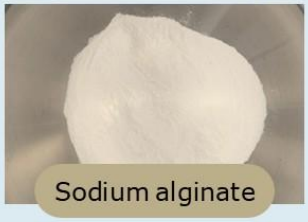
Do it yourself!
Zero-Waste
Seaweed Coatings for Cosmetics
SHARE THIS GUIDELINE!
PART OF THE
EU MISSIONS
RESTORE OUR OCEAN & WATERS
Co-funded by the European Union
Scientists against plastic
REMEDIES
NATIONAL INSTITUTE OF CHEMISTRY
Equipment and accessories
shampoo balls
STANDARD
approx. 250 balls
45 min
1 large metal bowl
2 small metal bowls
1 wodden bowl
1 spoon
2 small sieves
1 tray
Dehydrator/dryer
Handheld stick blender
Press gun

Ingredients

Tapioca starch
Stearic acid
Sodium alginate
Water (aqua)
Calcium Chloride
Menthol


Tapioca starch

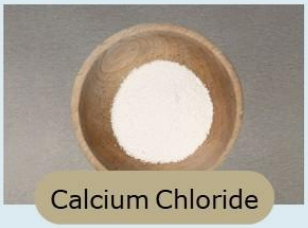

Stearic acid


Sodium alginate

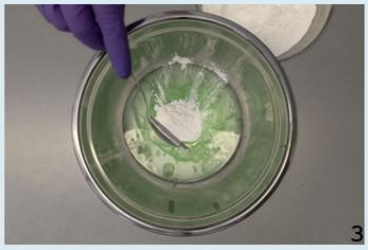

Water


Dehydrated liquid shampoo


Menthol


Calcium Chloride

Mixing of the shampoo dough



1 750 g of dehydrated shampoo (water content below 40%).

2 Mix 500 g of Tapioca Starch.

3 Add mixed powder to shampoo; approx. 1/3 at a time.

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4–6 First, mix the ingredients with a spoon, then knead with your hands.

7 The shampoo dough is ready when it no longer sticks to your hands or the bowl.

Making of shampoo balls

8 Spread tapioca starch with a sieve on a wooden surface.

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9 Use a spoon to transfer the shampoo dough into the press gun.

10-11 Apply pressure to the press gun handle to make lines of shampoo dough.

12-14 Cut the shampoo dough into equal pieces, approximately 1–1.5 cm wide.

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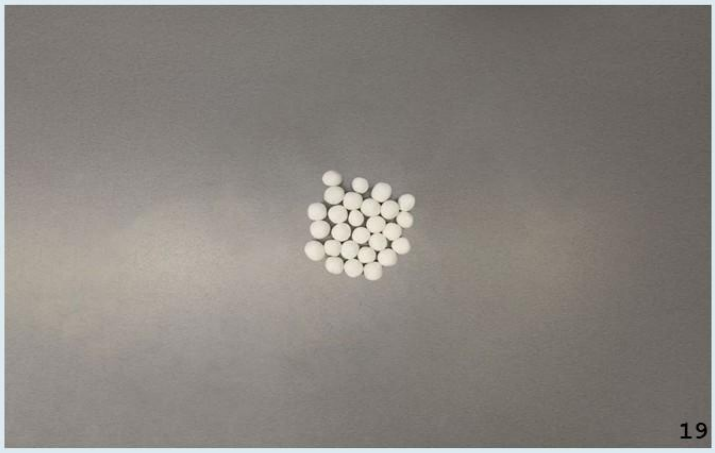
Take one piece in your hand and use the other hand to shape it into a ball.

15-18

Tip: Lightly dust your hands with starch before starting.



19 Place the balls on a surface and avoid them touching each other.

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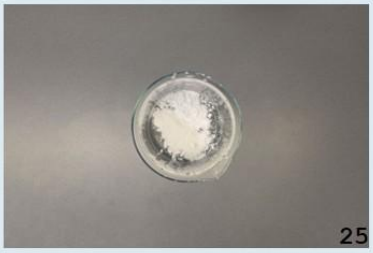
Preparing coating solution 1

Hand Blender



23–25 Add sodium alginate and tapioca starch to the water.

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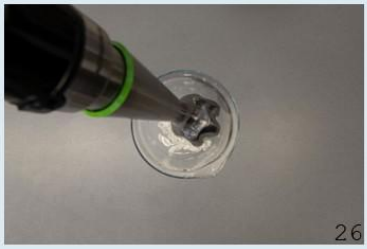
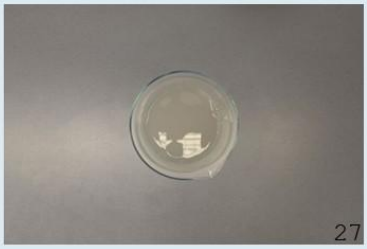
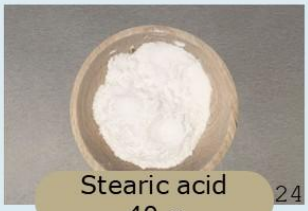


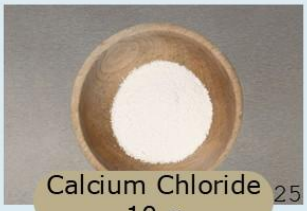


26 Blend until fully dissolved (approximately 3 minutes).

27 Coating solution 1.

Preparing coating solution 2





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REMEDIES
MEDITERRANEAN SEA BASIN LIGHTHOUSE

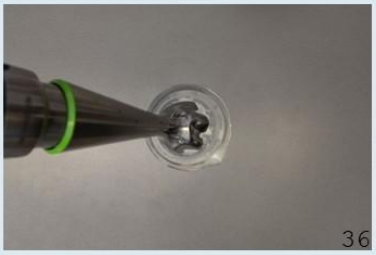
Preparing coating solution 2

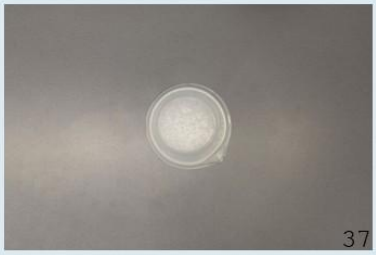

33


34


35

33–35 Add all ingredients into one beaker.


36


37

36 Blend until fully dissolved.

37 Coating solution 2.

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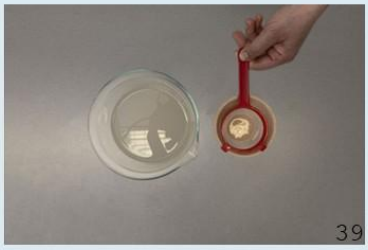
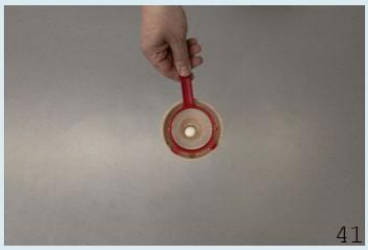
Coating the shampoo balls





38 Add 3 tablespoons of Coating Solution 1 to a small wooden bowl.

39–41 Wet the sieve with Coating Solution 1, then add the shampoo balls.

42 Prepare a larger bowl with Coating Solution 2.

43–44 Swirl the shampoo balls in the sieve to achieve a glossy finish, then transfer them to the bowl with Coating Solution 2. Let them sit for at least 10 seconds.

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Dehydrator-Dryer


45


46


47

45 Use another sieve to pick up the coated shampoo balls.

46 Place the shampoo balls in a container to dry for a few minutes.

47 As a final step, use an oven at 45°C with ventilation mode for 15 minutes.

Optional:

Repeat steps 33-40 multiple times for a thicker coating.

Zero-Waste Packaging Options


48


49


50

48 Refillable container – for home use.

49 Shelf storage without packaging – a minimal-waste option.

50 Paper box – ideal for travel.

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Figures 98-114: Overview of the steps by step guidance in demonstration of the seaweed zero-waste cosmetics-standard version (Authors: Tamara Bizjak, Dajana Jeglič, Uroš Novak)

6.5. Introduction to the workshop preparation document for organizers

This section covers the guide to workshop leaders' presentation preparation to perform citizen science demonstration on zero-waste cosmetic. This part of the workshops is a crucial to build upon the educational followed by a practical demonstration and final feedback on the results. To complete this process and with the citizens provide an entry data to build upon inclusive and gender unbiases approach when introducing new type of product with a zero-waste claims.

Suggested workshop template and presentation script prepared by NIC team based on the citizen interaction during the events and are prepared for the workshop leaders, to demonstrate both the innovation of the zero-waste seaweed cosmetics as well to advance the participants educational level.

(You can prepare Mentimeter presentation, which allows you to collect participants opinion and responses.)

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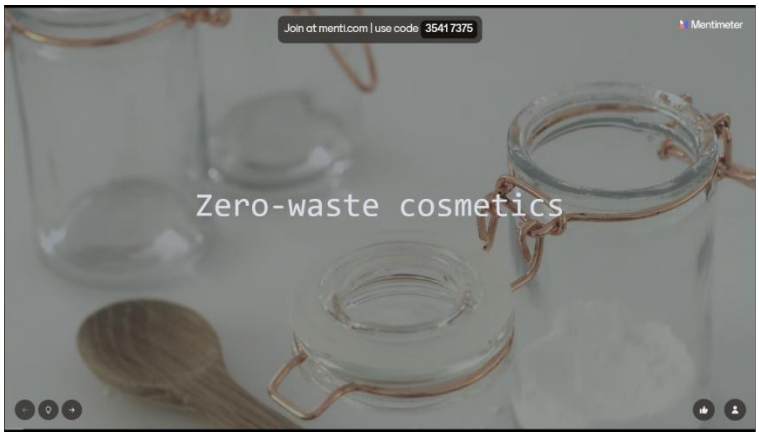
PART 1 - Introduction of the topic and collect the baseline knowledge and interest of the participants

Slide 1 - Title Slide



"Hello everyone, and welcome to today's workshop titled *Zero-Waste Cosmetics*.

Today, we'll explore how cosmetic products can be designed, used, and reimagined in a more sustainable way - with minimal waste and packaging.

This session will be interactive, so I encourage you to take part in the activities throughout."

Slide 2 - Instructions / QR Code

"Before we begin, please take your phone or laptop and scan the QR code on the screen. This will take you to our Mentimeter page, where you'll be able to vote, answer questions, and share your thoughts during the workshop. Don't worry - all responses are anonymous. The goal is simply to collect everyone's ideas and start a good discussion."

(pause to allow everyone to connect)

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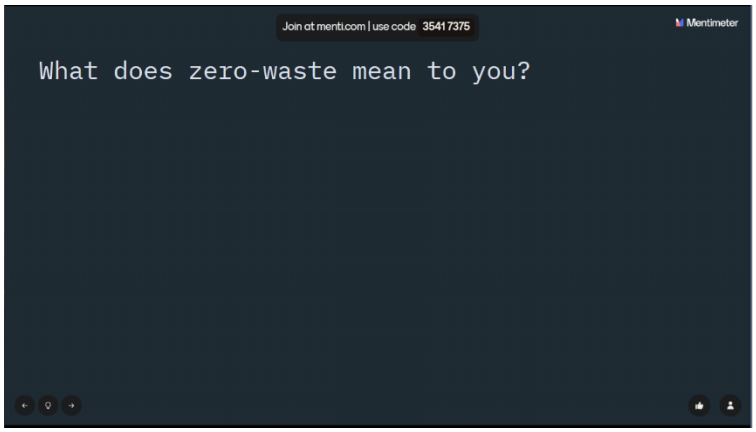


Slide 3 - What does zero-waste mean to you?

"To start off, let's see what zero-waste means to you personally.

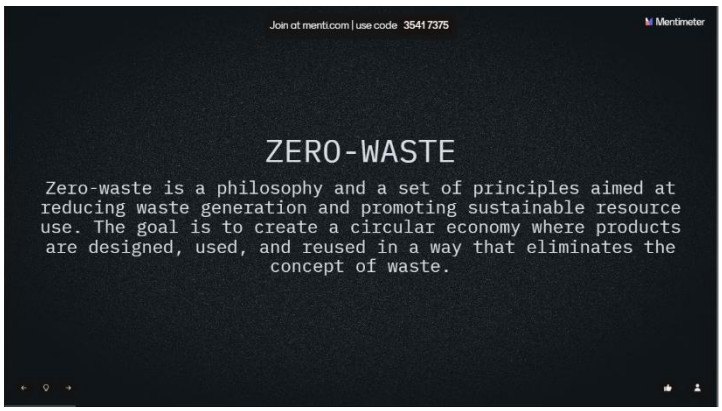
Type in the first few words that come to mind.

As you do, your answers will appear in the word cloud on the screen — the more often a word appears, the bigger it gets."

(after responses appear)

"Great! I see words like no packaging, recycling, sustainability, less waste - these are exactly the core ideas behind zero-waste thinking. Let's build on these together."

Slide 4 - Definition of Zero-Waste



"So, what exactly is zero-waste?

It's not just a trend, but a philosophy - a set of principles aimed at reducing waste generation and promoting the sustainable use of resources.

The goal is to create a circular economy, where products are designed, used, and reused in a way that eliminates the very concept of waste.

It's about changing how we think - from disposable to reusable, from linear to circular."

Slide 5 - Key Principles of Zero-Waste

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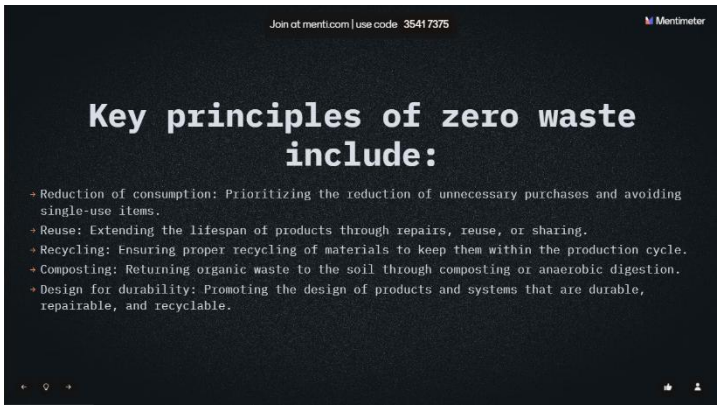
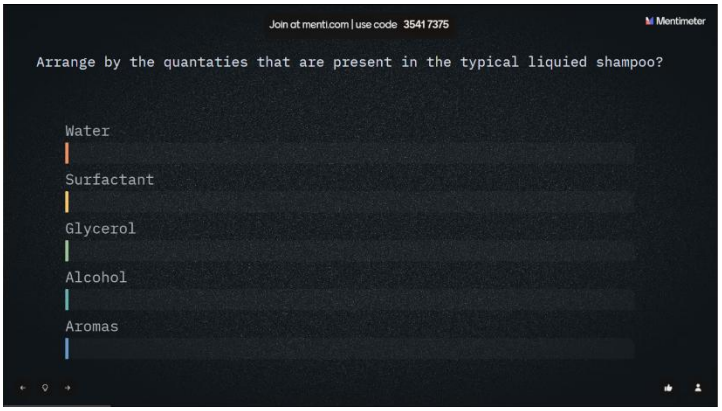


"The zero-waste approach is built on a few key principles:

Reduce consumption: Buy less and avoid unnecessary single-use products.
Reuse: Extend the life of products through repairing, reusing, or sharing. Recycle: Ensure proper recycling of materials to keep them in the production loop.
Compost: Return organic waste to the earth through composting or digestion.
Redesign: Encourage the design of durable, repairable, and recyclable products and systems. We'll see how these ideas apply to cosmetics in just a moment."

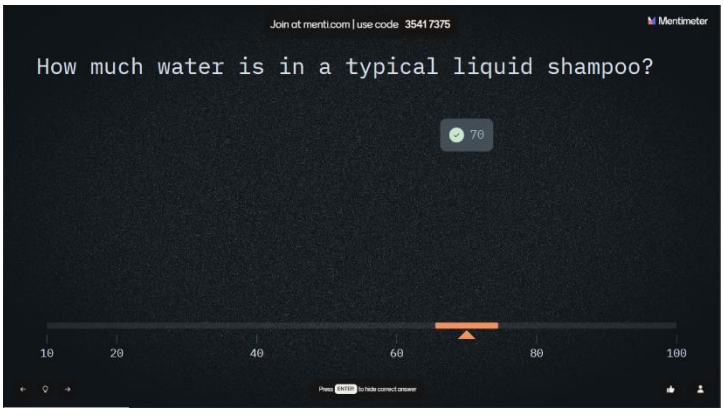


Slide 6 - Which ingredient is most common in shampoos?

"Let's make things more concrete - let's talk about shampoos!
Here's a quick quiz: *Which component do you think is most present in shampoo?*
Is it distilled water, glycerol, surfactant, alcohol, or fragrance?
Make your selection on your device."

(pause for voting)
"I can see that most of you chose distilled water - and that's absolutely correct!
Let's take a closer look at why that matters."

Slide 7 - How much water is in a regular shampoo?



"Next question — how much water do you think a typical liquid shampoo contains?
Enter your guess as a percentage."

(pause for results)
"The correct answer is around **70%** - more than half of a regular shampoo bottle is simply water!
That means more plastic packaging, heavier transport, and more energy used in production.

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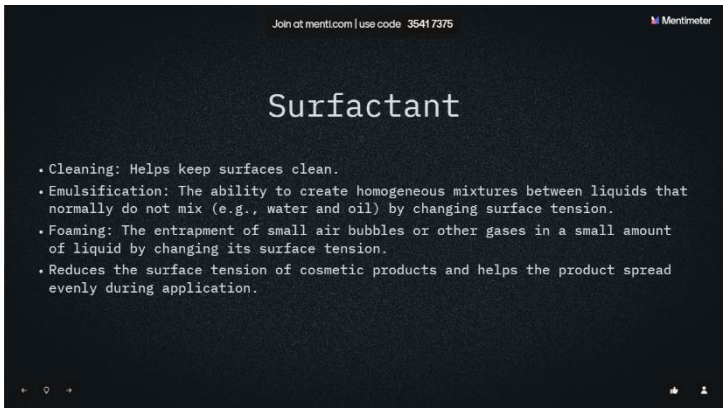
This is one of the main reasons why zero-waste cosmetics promote *solid*, *concentrated* forms - they eliminate unnecessary water from the formulation."

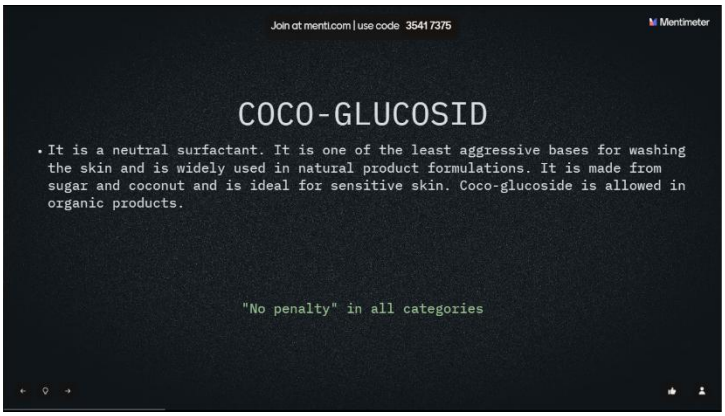
Slide 8 - Surfactant



"Now, let's look at one of the key ingredients: the **surfactant**.
Surfactants are surface-active agents that make cleaning possible.
They help mix water and oil, create foam, and remove dirt and grease.
Without surfactants, shampoo wouldn't lather or cleanse properly - but some of them can be quite harsh on the skin and the environment.

So, choosing the right one is crucial."

Slide 9 - Coco-Glucoside



"One of the gentlest surfactants is Coco-Glucoside.

It's a natural, plant-based surfactant made from sugar and coconut.

It's very mild, making it ideal for sensitive skin, and it's also approved for use in certified organic cosmetics.

So, when you're reading ingredient labels, this is one of the names you want to look for!"

Slide 10 - Glycerol

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"Another common ingredient is Glycerol, or glycerin.

It serves several purposes - it acts as a humectant that retains moisture in both the skin and the product, helps protect the skin from environmental stress, and makes hair soft, shiny, and easy to comb.

It also helps maintain the right consistency of the cosmetic product. In zero-waste cosmetics, we prefer using plant-based glycerine rather than synthetic versions."

End of Part 1

"So, that wraps up the first part of our workshop.

Invitation for participants to participate in survey about zero-waste cosmetics (example of the survey - share our link)

You now understand the key principles of zero-waste and how they relate to cosmetic formulations.

In the next section, we'll move into practice - creating simple, sustainable cosmetic products and seeing how small changes in formulation can make a big environmental difference."

PART 2 - Workshop

Invitation to scan or share the slides on the monitor for participants to follow the steps. There are three variations of the demonstration that can be tailored for the event type or other requirements.

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Figure 115: QR codes with the link to the guidelines for step-by-step production of zero-waste seaweed coating cosmetics.

PART 3 - Harvesting of the results

Thank you for joining our zero-waste cosmetics workshop series. You've learned how to reduce waste, reuse ingredients, and design sustainable routines. We hope you leave inspired to apply these practices at home, share the knowledge with others, and continue exploring innovative, eco-friendly cosmetic solutions.

You are further invited to co-create methodology via provide feedback on the workshop they participated.

Figure 116: QR code for participants after the workshop

Preferably with the previously answered survey about their common knowledge and about zero-waste and are as last step invited to perform a final test of the produced zero-waste shampoo or shower gel balls in the environment of their own choosing thus to complete the innovation pathways from educated to engaged to conscious plastic free or zero-waste individual.

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Figure 117: QR code to zero-waste cosmetics with seaweed coating product testing survey.

PART 4 - Workshop impact reporting to REMEDIES dashboard by the workshop leader

Figure 118: QR code with the link to survey to report the workshops or event to REMEDIES dashboard.

6.5.1 Tutorial videos

As an option or in the individual setting a YouTube tutorial videos playlist[62] where every individual can participate and become engaged in the activities from home (Figure 119).

[62] https://youtube.com/playlist?list=PLJA9dy7l38YSNxTeNaPqM_KCJ5GoAzZwn&si=1uOAEPJD3x_VnPxH (Accessed 1.12.2025)

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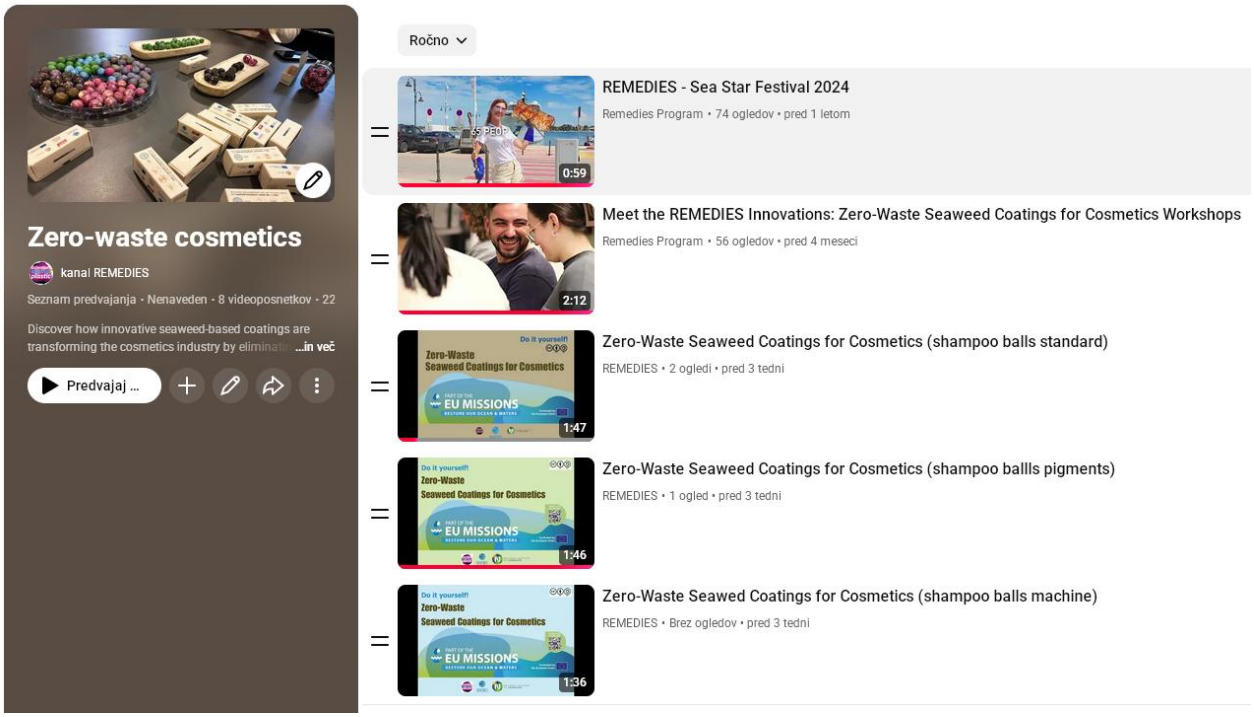

Figure 119: Zero-waste cosmetics YouTube playlist created to support REMEDIES zero-waste seaweed coating cosmetics.

The playlist is inviting the public to discover how innovative seaweed-based coatings are transforming the cosmetics industry by eliminating single-use plastic bottles. Each dissolvable "cosmetic ball" replaces traditional packaging, offering a fully biodegradable, zero-waste alternative that reduces plastic at the source. This technology supports: Major plastic waste reduction - tackling over 100 billion single-use units produced globally each year. Sustainable habits - encouraging individuals, businesses, hospitality, and sports centres to switch to effortless, eco-friendly solutions. High-impact sectors - perfect for tourism, hotels, gyms, and high-traffic areas where waste is generated the most. Explore the future of sustainable cosmetics - plastic-free, zero-waste, and powered by nature.

6.6. Surveys to collect data from citizen science participant

The survey was designed to collect a general knowledge on zero-waste cosmetics, the knowledge and feedback from the workshops attendance or people used do-it-yourself guidelines, product use evaluation and a reporting survey to enable group of citizens to share their data on the REMEDIES dashboard. The surveys were designed and cocreated as a methodology with the citizen science at the event, where it was used and refined afterwards upon the received feedback. Moreover, a gender dimension questions was employed to the questionnaire allowing the assessment on that regard. The recipients of the answers from the survey are NIC researchers, who will in compliment with the GDPR provide a data from the surveys a FAIR and open access.

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6.6.1 Zero-Waste Cosmetics General Survey

Introduction

Dear Participant,

we would like to invite you to participate in a research survey focused on zero-waste cosmetics. The purpose of this research is to understand your opinion and experiences related to the zero-waste concept and the use of zero-waste cosmetics. By sharing your thoughts and experiences, you will contribute to a better understanding and development of zero-waste practices and education on sustainable living. Your anonymous responses will provide valuable insights that will later be presented at upcoming workshops and events focused on sustainable development.

This survey is part of the Mission Ocean and Waters Horizon Europe project REMEDIES (GA number 101093964), which is carried out in partnership with research group of the National Institute of Chemistry from Slovenia- Scientists Against Plastic, led by Dr. Uroš Novak.

As stated previously, the survey will gather your information anonymously, and your data will therefore be treated confidentially. We kindly ask that you fill out the following survey, which will take approximately 5 minutes.

Instructions for Filling Out the Survey: Please circle or check the appropriate responses, where indicated, or provide a written response where required.

We appreciate your time and thank you in advance for your valuable contribution to this important research!

Best regards,

Scientists against plastic/ National Institute of Chemistry

Demographic information

1. **What is your gender?**
   - Male
   - Female
   - Non-binary
     Prefer not to say
2. **2. What is your age group?**
   - Under 18
   - 18-24

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- 25-34
- 35-44
- 45-54
- 55-64
- 65 and older
- Other

Awareness and Usage of Zero-waste cosmetics

3. **How familiar are you with the concept of zero-waste cosmetics?**
   - Very familiar
   - Somewhat familiar
   - Not familiar
4. **Have you ever used zero-waste cosmetic products?**
   - Yes
   - No
   - Maybe
5. **Which types of zero-waste cosmetic products have you used? (Select all that apply)**
   - Shampoo bars
   - Solid moisturizers
   - Refillable makeup
   - Other

Attitudes and Preferences

6. **How important is sustainability in your purchasing decisions for cosmetics?**
   - Very important
   - Somewhat important
   - Not important
7. **What factors influence your decision to purchase zero-waste cosmetics? (Select all that apply)**
   - Environmental impact

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- Price
- Brand reputation
- Ingredients used
- Packaging design

8. **Would you consider buying a cosmetic product that features gender-neutral colors (e.g., colors like green, yellow, teal, or gray)?**
   - Yes
   - No
   - Maybe

Barriers and Challenges

9. **What challenges do you face when purchasing zero-waste cosmetics? (Select all that apply)**
   - Limited availability
   - Higher cost
   - Lack of information
   - Unsure of effectiveness
   - Other

10. **Would you be willing to pay more for zero-waste cosmetics compared to traditional products?**
    - Yes
    - No
    - Depends on the product

10.1 **You said that it depends on the product: What are the criteria (e.g. need, allergies, etc.)?**

Understanding Zero-Waste

11. **Which description of zero-waste is closest to your understanding?**
    - A lifestyle that aims to eliminate waste by reducing, reusing, and recycling materials.
    - A trend focused solely on using biodegradable products without considering packaging.
    - A way to minimize plastic use while still producing some waste.

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Feedback and Suggestions

12. What improvements would you like to see in zero-waste cosmetic products?

13. Do you have any additional comments or suggestions regarding zero-waste cosmetics?

14. Would you be interested in participating in further discussions or focus groups about zero-waste cosmetics?

- Yes
- No

Email

Please share your email so that we can contact you regarding participation in further discussions or focus groups about zero-waste cosmetics:

6.6.2 Survey for participants in zero-waste cosmetics workshop

Dear Participant,

we would like to invite you to participate in a research survey, focused on zero-waste cosmetics workshop. The purpose of this research is to understand your opinions related to the DIY seaweed zero-waste cosmetics coatings workshop you have participated in. By sharing your thoughts and experiences, you will contribute to a better understanding and development of zero-waste practices and education on sustainable living. Your anonymous responses will provide valuable insights that will later be presented at upcoming events focused on sustainable development.

This survey is part of the Mission Ocean and Waters Horizon Europe project REMEDIES (GA number 101093964), which is carried out in partnership with research group of the National Institute of Chemistry from Slovenia - Scientists Against Plastic, led by Dr. Uroš Novak.

As stated previously, the survey will gather your information anonymously, and your data will therefore be treated confidentially. We kindly ask that you fill out the following survey, which will take approximately 5 minutes.

Instructions for Filling Out the Survey: Please circle or check the appropriate responses, where indicated, or provide a written response where required.

We appreciate your time and thank you in advance for your valuable contribution to this important research! Best regards,

Scientists against plastic/ National Institute of Chemistry

Demographic information

Co-funded by the European Union

1. **Age group:**
    - Under 18
    - 18-24
    - 25-34
    - 35-44
    - 45-54
    - 55-64
    - 65 and older
2. **Gender:**
    - Male
    - Female
    - Non-binary
    - Prefer not to say
3. **Nationality:**
4. **Living area:**

- Rural
- Urban

5. **Do you have children?**
    - Yes
    - No

Zero-Waste Awareness

6. **Are you familiar with the zero-waste concept?**
    - Yes
    - No
7. **How would you define it in your own words?**

Awareness and Usage of Zero-waste cosmetics

Co-funded by the European Union

8. **What kinds of zero-waste alternatives or products do you use in your daily life? (e.g., reusable bags, compostable items, etc.)**
9. **What motivates you (or would motivate you) to adopt zero-waste habits?**
10. **I used zero-waste cosmetics before the workshop.**
    - Yes
    - No
11. **Which zero-waste cosmetics have you used and how often?**

Participant Background

12. **Do you have any allergies to specific cosmetic products or ingredients?**
13. **Do you consider yourself environmentally conscious?**
    - Yes
    - No
    - Sometimes

Participation in Events

14. **Have you ever participated in a zero-waste event or workshop?**
    - Yes
    - No
15. **Which zero-waste event or workshop have you participated in?**
16. **Would you prefer more gender-inclusive language in future workshops?**
    - Yes
    - No
    - No opinion

Learning and Engagement

17. **Please rate the following statements on a scale of 1-5 (1 = Strongly Disagree, 5 = Strongly Agree):**

I learned something new about the zero-waste lifestyle. 1 2 3 4 5

I learned something new about zero-waste products. 1 2 3 4 5

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I learned something new about zero-waste cosmetics. 1 2 3 4 5

I will consider buying zero-waste cosmetics more often from now on. 1 2 3 4 5

I will consider buying zero-waste products more often from now on. 1 2 3 4 5

I will adopt more zero-waste practices from now on. 1 2 3 4 5

I will share the knowledge gained at the zero-waste workshops with others. 1 2 3 4 5

I would like to see more workshops like this at different events in the future. 1 2 3 4 5

Workshop Feedback

18. How difficult did you find the workshop?

- Very easy
- Easy
- Moderate
- Difficult
- Very difficult
- Other

19. How interesting did you find the workshop?

- Extremely interesting
- Interesting
- Average
- Slightly interesting
- Not interesting at all
- Other

How clear were the instructions?

20. Which part of the process felt the most challenging?

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21. **How useful do you think the shampoo ball solution is for reducing plastic waste?**
22. **Would you consider using such products instead of plastic packaging?**
    - Yes
    - Maybe
    - No
    - Other
23. **How could the workshop be improved?**
24. **Please share one key takeaway or message you would like to pass on to future participants or the workshop organizers.**
25. **Is there anything else you would like to add?**

6.6.3 Survey for Zero-Waste Cosmetics - Product Use Evaluation

Dear Participant,

Thank you for taking part in the zero-waste cosmetics workshop and contributing to the reduction of plastic containers by creating zero-waste shampoo balls.

We kindly invite you to participate in a research survey focused on your satisfaction after using zero-waste cosmetic products. The purpose of this survey is to better understand your opinions regarding the quality of the Do-it-Yourself seaweed zero-waste cosmetic coatings you tested. By sharing your thoughts and experiences, will help understand user needs and supporting the further development of sustainable, plastic-free solutions within the REMEDIES project. Furthermore, your anonymous responses will provide valuable insights that will be presented at upcoming events dedicated to sustainable development.

This survey is part of the Mission Ocean and Waters Horizon Europe project **REMEDIES** https://remedies-for-ocean.eu/ (GA number 101093964), carried out in partnership with the **Scientists Against Plastic** research group at the National Institute of Chemistry in Slovenia, led by Dr. Uroš Novak (https://si.linkedin.com/in/uros-novak-scientistagainstplastic).

As previously stated, the survey is anonymous, and your data will be treated confidentially. We kindly ask you to complete the following questionnaire, which takes approximately 3-5 minutes.

Instructions for Completing the Survey:

Please check the appropriate response where indicated or provide a written answer where required.

We appreciate your time and thank you in advance for your valuable contribution to this important research!

Best regards,

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General Opinion About the Product

This section focuses on your overall impressions of the zero-waste cosmetic product you tested. You will be asked to evaluate key characteristics such as appearance, scent, texture, ease of use, and overall quality. Your feedback will help us understand how well the product meets user expectations and identify opportunities for improvement in future zero-waste cosmetic developments.

1. **How practical is the zero-waste cosmetic product for your daily use?**
2. **List good characteristics about the product you used:**
3. **List bad characteristics about the product you used:**

Product Characteristics

In this section, you will evaluate the fundamental attributes of the zero-waste cosmetic product, including its lathering ability, scent, texture, shape, and overall appearance. Your feedback will help us assess the product's quality and identify which characteristics work well and which may require improvement.

4. **How would you rate the product's lathering performance?**
    - Excellent
    - Very good
    - Okay
    - Poor
    - Very poor
    - I do not want to answer.
5. **How would you rate the ease of applying the product during washing?**
    - Excellent
    - Very good
    - Okay
    - Poor
    - Very poor
    - I do not want to answer.

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6. **How would you rate how well the product rinses off?**
    - Excellent
    - Very good
    - Okay
    - Poor
    - Very poor
    - I do not want to answer.
7. **How would you rate the overall feel of the product during washing?**
    - Excellent
    - Very good
    - Okay
    - Poor
    - Very poor
    - I do not want to answer.
8. **How would you rate the scent of the product?**
    - Excellent
    - Very good
    - Okay
    - Poor
    - Very poor
    - I do not want to answer.
9. **How would you rate the appearance of the product?**
    - Excellent
    - Very good
    - Okay
    - Poor
    - Very poor

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- I do not want to answer.

10. How would you rate the shape and consistency of the product?

- Excellent
- Very good
- Okay
- Poor
- Very poor
- I do not want to answer.

User Adoption & Recommendations

This section focuses on how likely you are to adopt the product in the future, share it with others, and provide suggestions for further development.

11. How likely are you to use this type of product long-term?

- Very likely
- Likely
- Not sure
- Unlikely
- Never
- I do not want to answer.

12. How likely are you to recommend this product to others?

- Very likely
- Likely
- Not sure
- Unlikely
- Never
- I do not want to answer.

13. Do you have any recommendations for how the zero-waste product could be improved or upgraded?

Conclusion

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Thank you for taking the time to complete this survey and share your valuable feedback.

Your insights and experiences play an important role in evaluating and improving zero-waste cosmetic products developed within the REMEDIES project.

Thank you once again for your time and meaningful contribution.

6.6.4 Workshop Reporting

Dear Participant,

Thank you for choosing to carry out the zero-waste cosmetics workshop using the prepared protocol published on REMEDIES project's website. By implementing this activity, you play an essential role in expanding knowledge, promoting hands-on learning, and supporting the wider adoption of zero-waste cosmetics in your community.

We kindly invite you to complete the following survey, which focuses on collecting key information about the workshop you conducted. The data you provide will remain anonymous and will only be used for uploading progress updates to the REMEDIES Dashboard. This platform will publicly showcase the implementation of zero-waste innovations across different regions.

This survey is part of the Mission Ocean and Waters Horizon Europe project **REMEDIES** https://remedies-for-ocean.eu/ (GA number 101093964), carried out in partnership with the **Scientists Against Plastic** research group at the National Institute of Chemistry in Slovenia, led by Dr. Uroš Novak (https://si.linkedin.com/in/uros-novak-scientistagainstplastic).

As stated previously, the survey is anonymous, and your data will be treated confidentially. Completing it will take approximately **3-5 minutes.**

Instructions for Completing the Survey:

Please check the appropriate response where indicated, or provide a written answer where required.

We appreciate your time and thank you in advance for your valuable contribution to this important research.

Best regards,

Scientists Against Plastic / National Institute of Chemistry

Workshop Information

1. **Country where the workshop was held:**
2. **Type of institution hosting the workshop:**

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- Preschool
- Elementary school
- High School
- University
- NGO
- Research Institution
- Public Institution
- Private Company
- Community Center
- Other

3. **Date of workshop:**
4. **Total duration of the workshop (in hours):**

Participation Information

5. **Total number of participants:**
6. **Gender distribution: How many participants were male?**
7. **Gender distribution: How many participants were female?**
8. **Gender distribution: How many participants were non-binary?**
9. **How many participants with disabilities attended the workshop?**
10. **Disabilities present:**
    - Physical disability
    - Sensory disability (e.g., visual, hearing)
    - Cognitive or learning disability
    - Prefer not to answer
    - Other

Workshop Outputs

11. **How many zero-waste shampoo or shower gel products (balls) were created during the workshop?**

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12. What kind of secondary packaging were chosen to transfer the zero-waste cosmetics to your home or destination?

- Glass container
- Paper or cardboard box
- Aluminium foil
- Plastic bag
- Wooden box
- No packaging direct use at the side
- Other

13. Were other zero-waste products prepared?

Additional Information

14. Choose the workshop activities performed (optional):

- Introduction to workshop
- Participant participated to share their know-how and experience with zero-waste cosmetics
- Participant were engaged in the preparation of the zero-waste shampoo or other cosmetic product
- Participants were engaged only in preparation of seaweed zero-waste coating
- Participants were informed and asked to fill out the survey for participants in zero-waste cosmetics workshop
- Sharing their evaluation of the product to the REMEDIES Dashboard
- Other

15. Any notable observations from the organizers (optional):

Thank you for your valuable contribution!

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Chapter 7: Conclusion and final remarks

The authors of this public deliverable share the following lessons learned during the 2023 - 2025 period, which will be further applied in citizen science activities on zero-waste cosmetics as an important niche in the cosmetics packaging sector. The workshop sequence - educational content, practical demonstration, and final feedback - was identified as crucial for effective learning and engagement. By completing this process with participants, we establish a data-driven entry point that supports an inclusive, gender-balanced approach when introducing new products with zero-waste claims. Thus, we believe citizen science activities and demonstrations can be used as an efficient tool to mobilize the future consumers to influence the cosmetics sector towards alternatives to plastic as the main packaging material solution.

The lessons include that this is a highly relevant topic (SRL 7+), with citizens increasingly seeking practical solutions to avoid plastic and becoming more conscious of plastic use in their daily choices and community activities. To support this shift, it is essential to improve communication about zero-waste cosmetics, making the concept accessible, actionable, and easy to understand for diverse audiences. As a potential next step is providing Do-it-yourself guidelines in multiple languages, with clearly explained, simplified options, helps remove language and complexity barriers, enabling broader participation. Including clear contact information and user-friendly web content ensures people can reach us, share their activities, and contribute feedback directly, creating a connected community of practice. Inviting audiences to co-create activities fosters deeper engagement, empowers participation, and accelerates the adoption of sustainable cosmetics. It is also important to present tangible examples, success stories, and practical steps that individuals can implement immediately, as well as pathways for educational institutions, businesses, and policymakers to collaborate. Continuous updates, transparent reporting, and an open feedback loop help maintain trust and demonstrate progress towards reducing plastic use and advancing zero-waste design in cosmetics.

In 2026, the zero-waste cosmetics workshop concept will be featured on the REMEDIES website as a Citizen Science educational protocol for preparing Zero-Waste Seaweed Coatings for Cosmetics. As a direct citizen participation activity, survey results will be communicated through the REMEDIES dashboard, which will serve as an open-access tool to disseminate outcomes written by participants themselves. Survey results will undergo review by a (social) scientist, and a scientific publication will be prepared, with the addition of gender-dimension criteria by the NIC team in 2026. Consequently, reporting on survey results within this deliverable is not foreseen, since it will be part of the open-access publication. Next steps include continuous promotion and activation of the co-created tools for citizens, implementing the dashboard dissemination, finalizing the gender-dimension criteria, and coordinating publication timelines.

D3.3 output includes three open-access citizen guidelines, additional educational citizen-engagement materials, a promotional video, and a survey to capture initial participant assessments and workshop feedback. Our citizen-science demonstrations reached over 500.000 people and engaged over 1.400 participants so far and, through a co-creation process with citizens, produced over 5.000 seaweed-coated shampoo balls. Do-it-yourself guidelines were downloaded and surveys filled out by more than 150+ citizens, leading to potential replication or feedback supporting the citizen consciousness about zero-waste and its solutions.

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NIC zero-waste cosmetics citizen science was also accepted into the Horizon Booster[63] the Go-to-Market support service to focus on different aspects such as increasing the maturity level of Key Exploitable Results, developing effective business plans to facilitate citizen engagement, access and impact, and identifying opportunities for further exploitation or reuse of research results.

[63] https://www.horizonresultsbooster.eu/ (Accessed 23.12.2025)

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