GROOM II

GLIDERS FOR RESEARCH, OCEAN OBSERVATION & MANAGEMENT : INFRASTRUCTURE AND INNOVATION

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Author(s) – in alphabetical order	
AUREGAN Charlène BOURILLON Chloé RUEL Colin	Pôle Mer Méditerranée
BARAONA Patrick	StratMar Conseil
DIRKS Jessica LUCAS Charlotte	ECORYS
HAYES Dan REODICA Jerald	CSCS

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Deliverable abstract

This deliverable aims at presenting recommendations for building partnerships between SMEs, large industry, academics, NGOs, and public and private entities. It will describe these recommended methods to implement for each type of partnership. This deliverable will present:

- How the Industry Advisory Group for Marine Autonomous Systems (IAG-MAS) was created to ensure continued evolution of marine autonomous system services, thus creating a sustained relationship with industry.
- A market feasibility study to analyse target markets.
- Recommendations on the positioning of the GROOM RI on the target markets.

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List of Abbreviations

Argo	Scientific international programme for ocean observation using a fleet of robots
ASV	Autonomous Surface Vehicle
AUV	Autonomous Underwater Vehicle
BTCA	BlueTech Cluster Alliance
CSCS	Cyprus Subsea Consulting and Services C.S.C.S. Ltd.
EC	European Commission
EMBRC	European Marine Biological Resource Centre
EMODnet	European Marine Observation and Data Network
EMSO	European Multidisciplinary Seafloor and water column Observatory
EOOS	European Ocean Observing System
Euro-Argo	European contribution to the Argo Programme
GOOS	Global Ocean Observing System
IAG-MAS	Industry Advisory Group for Marine Autonomous Systems
JERICO	Joint European Research Infrastructure of Coastal Observatories: Science, Service, Sustainability
MAS	Marine Autonomous Systems
MRI	Marine Research Infrastructure
MS	Member States
PMM	Pôle Mer Méditerranée
R&D	Research & Development
RI	Research Infrastructure
SME	Small and Medium Enterprise
WP	Work Package

1. GROOM RI – Background and Context

Underwater and surface drones, in particular gliders, have become essential vehicles to carry scientific payloads for most environmental observations from the surface down to 6000 m. These marine autonomous systems (MAS) and associated activities support the blue economy. Autonomous marine vehicles have inherent major advantages including their mobility, steerability, persistence, and usability in large numbers at relatively low costs. However, the distributed infrastructure required to exploit these assets must be able to meet different demands from research and marine environmental monitoring to public service missions and industry's needs. These various scenarios require customised payloads and operations. The rapid evolution of robotics, artificial intelligence (AI), miniaturised sensors, and big data require that the R&D resources offered by this distributed infrastructure continuously adapt to users' demands.

The complex hardware and information technology characteristics of such a distributed European infrastructure were analysed during the GROOM-FP7 design study from the perspective of researchers and the needs of Global and (future) European Ocean Observing Systems (GOOS & EOOS). In short, the design study began the process to determine how to optimise access to resources and R&D for gliders. Since then, several "gliderports" have developed which has fostered a corresponding European industrial innovative sector.

Building on its predecessor, GROOM II will deliver the decision basis for an advanced Marine Research Infrastructure (MRI) that promotes scientific excellence, fosters innovation, support the blue economy, builds industrial and public partnerships, and works toward helping achieve the common research and innovation mission for future Europe. The project will define the overall organisation of an infrastructure dedicated to ocean research and innovation, and maritime services supporting Blue Growth: GROOM RI.

GROOM RI will be a positive force to unite today's fragmented European MRI landscape -- aiding connections and synergies for the completion of GOOS and EOOS. Indeed, this potential MRI will act as a facilitator which aims to promote the products & services offered by European industry and develop healthy collaborations between researchers and industry.

2. Methodology

2.1 Introduction

This deliverable is based on research and the consultation of key stakeholders, through two complementary means: the Industry Advisory Group for Marine Autonomous Systems (IAG-MAS) and a survey regarding the future GROOM RI directed to key players in the marine technology industry. The IAG-MAS members gathered for 3 workshops to discuss 3 topics of interest regarding the future collaboration between the MRI and industry. A limited number of key marine technology stakeholders were present during each workshop to ensure a focused discussion. The survey complemented the IAG-MAS workshops by extending the range of respondents to key players which were not part of the advisory group.

The future GROOM RI intends to establish strong relationships between industrial and scientific stakeholders by sharing resources (e.g., infrastructures, vehicles, data, and know-how). One positive result of GROOM RI will be the creation of new public-private collaborations. By specifically identifying the needs of industry, GROOM II partners have the confidence to design an optimal future RI. Additionally, this report goes further than the feedback collected among industrials and analyses different marine markets.

2.2 IAG-MAS: Industry Advisory Group for Marine Autonomous Systems

This section will present the Industry Advisory Group for Marine Autonomous Systems (IAG-MAS): its objectives, members, and content of members' discussions.

2.2.1 Concept and Objectives

The IAG-MAS brought together leaders from over 20 organisations that specialise in manufacturing marine autonomous platforms and marine sensors as well as maritime service providers. This group unites professionals with considerable technical, commercial, and manufacturing expertise in the marine autonomous system space – from AUV fleet operators to marine surveyors to environmental monitoring data scientists and maritime security executives.

Based on the analysis of different local contexts and on national and European priorities, the objectives of this group were to:

- Establish a strong relationship between industrial and scientific/technical stakeholders. These stakeholders are the potential users of GROOM RI and determining their primary motivations to participate in and utilize GROOM RI services was prominent – whether delivering ecosystem health EOVs to EMODnet, climate EOVs to GOOS/ICOOS, Dual Use, Emergency Response, offshore wind energy, infrastructure inspection wind or pipelines/cables, mining, maritime shipping, etc.
- Develop a cooperative framework between research performers in the infrastructure and service providers.
- Provide the means for coordinating industry involvement when defining:
    - Key societal benefits of a sustained glider infrastructure.
    - Environmental services for industries by outlining the potential services that the future infrastructure may potentially offer to industries that benefit from marine monitoring.

- Services for new emerging markets by identifying and evaluating potential high-impact services that the GROOM RI may potentially provide to new and emerging markets supporting the blue economy.

- Identify and advance industry/science priorities for innovation by developing new glider products and applications.

2.2.2 Members selection

GROOM II consortium determined which industrial players were key to and could be involved in the IAG-MAS, including marine autonomous system users, sensor makers, and platform manufacturers. Research organisations from the GROOM II Project were also invited to participate.

As a basis for the composition of the IAG-MAS, organisers decided to limit the number of participants to optimise the discussions and create close links between industry and the future GROOM RI. A breakdown of the potential group includes:

- 2 - 4 users with an EU dimension – emergency response, border security, operational services like NATO, offshore survey person like Ocean Infinity, WOC-French representative, etc.
- 2 - 4 sensor makers that are key to the most attractive services the RI is targeting.
- 2 - 4 platform makers and possibly including newcomers, like Spray or Hefring.
- CSCS representatives
- PMM representatives
- 2 research representatives, ideally from the GROOM II consortium (people associated with MSFD and/or GOOS/ICOOS)

To select key industry players, GROOM II partners compiled a list from their network. More than 60 individuals with experience manufacturing marine autonomous platforms and sensors as well as marine service providers were contacted. Originally, 24 people representing 23 organisations joined the IAG-MAS. Over the different workshops, 6 individuals joined the IAG-MAS. In total, 30 people from 25 organisations participated in the IAG-MAS, with a majority of them associated with environmental monitoring, the offshore industry, and security companies.

2.2.3 The Workshops

PRESENTATION OF THE WORKSHOPS

Three online workshops took place between April and October 2022, on the following topics:

- Environmental services for industry's existing needs (11th April 2022) – 27 participants
- Emerging sectors and innovations: priorities, targets and why? (14th June 2022) – 23 participants
- Cooperation between industry and GROOM Research Infrastructure. (4th October 2022) – 24 participants

Each workshop gathered a sustained number of participants, showing a clear interest from the members to be involved in the design of GROOM RI.

MAIN CONCLUSIONS

GROOM RI partners structured the workshops to stimulate discussions among IAG-MAS members on the design of the future RI and how to support companies with the development of their projects. These workshops allowed GROOM II partners to identify:

- Industrial members' expectations regarding the RI
- Emerging sectors that the RI should target
- Type of services the RI should be able to provide
- Legal status the RI should have to maximise industrial involvement

IAG-MAS members identified the following emerging specialities for GROOM RI to prioritise:

1) Impact of offshore marine renewable energy infrastructure on coastal ecosystems
2) Underwater communication
3) Cooperation between several MAS

According to the IAG-MAS members, the most beneficial services that the RI could provide are the following:

Category of service	Services
Environmental monitoring	Baseline environmental surveys on water biogeochemistry, currents, waves, cetaceans
	Meeting regulations during offshore activities
	Providing monitoring services for national governments using MAS: MSFD noise, oxygen, chlorophyll levels
Mission planning & piloting	Access to the glider facilities, vehicles, sensors, and pilots
	Template for diplomatic clearance requests for MSR
	Shared planning, campaign coordination, piloting, and e-infrastructure tools, including risk management tools
Hardware maintenance & development	Scientific validation
	Sensor integration and testing
	Technology development
Engineering services	Sensor calibration
Data management	FAIR Data dissemination into GOOS, EOOS, and ENVRI communities
	Online portal for access as part of the e-infrastructure
Capacity building & training	Best practices with a link to Ocean Best Practices System (OBPS)
	Training

Table 1 – Beneficial services for Industrials that the RI could provide

The meeting minutes of the three IAG-MAS workshops are available in Annex 5.1. The power point presentations made for each workshop are stored on GROOM II Project's cloud and available upon request.

2.3 QUESTIONNAIRE

This section of the deliverable presents the methodology utilized by PMM-TVT and StratMar to conduct a survey identifying the key industrial players' expectations regarding the future GROOM RI. The method includes the identification of key industrial players, generation of focused questions, collection of responses, and analysis of the survey results about potential future collaborations and involvement with GROOM RI.

To enhance the response rate, the results of this survey have been used for two deliverables: D3.3 – Financial sustainability with industry and this one. The survey was divided into three parts as followed:

- Expectations and needs (results were primarily for D3.3)
- Markets and positioning (results primarily for D5.2)
- Industrials' involvement in the RI (results primarily for D3.3)

2.3.1 Target identification

The main target of this survey is European companies using and/or designing and manufacturing MAS and their components – either directly or indirectly (e.g., data management, marine research, modelling).

GROOM II partners identified the critical European companies within their networks and with extensive knowledge of the marine technology market. All partners have been asked to communicate the survey to any company using MAS and to encourage them to answer. This approach maximised the participation rate as GROOM II partners are well-established in the sector. Members of IAG-MAS were also prompted to complete the survey.

In addition, the Blue Tech Cluster Alliance (BTCA) (of which Pôle Mer Méditerranée - Toulon Var Technologies [PMM-TVT] is a member) identified and encouraged relevant stakeholders within its network to complete the survey. This Alliance is a global network of industry-led blue technology clusters which aims at promoting "investment and growth of the knowledge-based ocean and water industries, to the mutual benefit of all parties, through active regional, national and international collaboration". Taking advantage of the network of the BTCA broadened the scope of the potential respondents.

2.3.2 Profile of the respondents

This survey was published on EU Survey and sent by email to key stakeholders to collect the perspectives of key industrial players. The questionnaire was disseminated between the 3rd of October and 10th of November 2022. This section presents how GROOM II partners identified respondents, ensure data protection, and analysed the collected data.

18 respondents from 6 European countries (Cyprus, France, Germany, Norway, United Kingdom, and Spain) and 2 non-European countries (Canada and the USA) answered the questionnaire that was initially sent to more than 60 companies. For this type of survey, a 33% response rate is a good result.

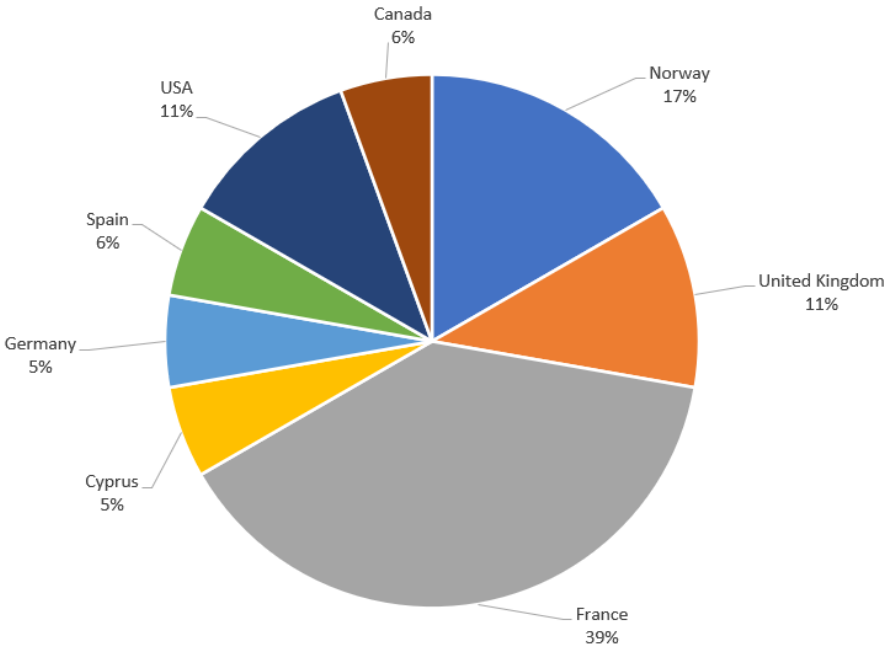


Figure 1 - Participation by country

Organisation	Country	Main activity
Kongsberg Maritime	Norway	Kongsberg Maritime is a world leader in marine technology. With an extensive portfolio of innovative and integrated products and solutions, this enterprise within the Kongsberg Gruppen delivers systems for positioning, surveying, navigation, and automation to merchant vessels and offshore installations. They're known for efficiency, reliability, flexibility, and environmental sustainability to enhance the business of its customers.
Offshore Sensing AS	Norway	As an SME, Offshore Sensing AS designs and manufactures surface vessels propelled by wind and electronics powered by solar panels. These surface vessels can carry a considerable number of observing oceanic sensors and cover long distances.
RS Aqua Ltd	United Kingdom	As an SME, RS Aqua Ltd helps ocean scientists and engineers explore further and discover more by providing technologies and unparalleled expertise. They are active in all fields of the blue economy, and their services include the operation of autonomous submarines and surface vehicles, ROVs, and gliders.
Sonardyne	United Kingdom	Sonardyne is one of the world leaders in acoustic submarine instrumentation technology. As a medium-sized company (MSC), it provides underwater technology and engineering services focused on the following markets: oil & gas, defence, MRE, and science.
Exail (ECA robotic)	France	Exail is one of the world leaders in autonomous and remotely operated submarines and surface vehicles. It provides solutions for smart navigation, photonics, and maritime autonomy. It is a MSC resulting from the merger of ECA Robotic and iXblue.

Cyprus Subsea	Cyprus	Cyprus Subsea Consulting and Services C.S.C.S. Ltd (CSCS) operates, maintains, develops, and supplies ocean gliders and other marine autonomous systems. As a consulting and services SME, they also deliver a range of marine services globally.
Alseamar	France	As the only glider manufacturer in Europe, Alseamar is a MSC that produces high-tech marine and submarine equipment. In addition, they provide innovative naval, subsea, and offshore services as well as engineering expertise for defence, energy, and observing the marine environment. They also operate unmanned surface and subsurface vehicles.
4H-JENA engineering GmbH	Germany	As an engineering SME and system supplier, 4H-JENA offers tailor-made measurement technology – form optical instruments, underwater measurements to the reconstruction of historical astronomical devices. One of its areas of expertise is underwater marine applications.
Subseatech	France	As an SME, Subseatech is specialised in the design, manufacturing, and servicing of marine and underwater solutions for inspection and investigation. It develops a large range of small ROVs and surface and submarine autonomous vehicles.
Nortek AS	Norway	As an SME, Nortek AS develops and produces scientific acoustic instruments (doppler effect) to measure physical parameters in the ocean such as water in motion.
SubSeaSail LLC	USA	As an SME, SubSeaSail LLC designs and manufactures unmanned autonomous surface vessels.
Naval Group	France	Naval Group is one of the world leaders in designing, building, and maintaining all types of naval combat ships including nuclear submarines as well as all types of surface ships including flight carriers. They are leaders in designing and manufacturing high value command control systems for monitoring the complex equipment of the warships including their weapons' system. Also, they develop and use autonomous surface and submarine vehicles.
INNOVA oceanografia litoral SL	Spain	As an SME, INNOVA oceanografia litoral SL is specialised in the study and analysis of environmental marine and coastal projects. They also provide oceanographic services with a large base of autonomous vehicles from several suppliers.
Sea Vorian	France	As an SME, Sea Vorian has two subsidiaries – Neotek, specialising in marine instrumentation, and RTSYS, specialising in underwater acoustics and autonomous vehicles. Their markets are marine environment, defence, and industry.
SeaTrac Systems, Inc.	USA	As an SME, SeaTrac Systems, Inc. designs and develops uncrewed surface vehicles for persistent in-shore and open ocean missions. Their target markets are marine defence, environment, and energy.
ABYSSA	France	As an SME, ABYSSA is dedicated to deep-sea exploration and operates in the world's oceans, up to 6,000m depth. It is an engineering and service company who defines the best solutions (surface vessel, AUV, and sensors) to answer the needs of their customers.

PREDICT	France	PREDECT is an affiliate SME company of the large Group SNEF. They specialise in high quality software for predictive maintenance and mission planning with the aide of AI algorithms. They are also involved in data collection and analysis.
AML Oceanographic	Canada	As an SME, AML Oceanographic manufactures high performance oceanographic and hydrographic instrumentation to collect marine data such as conductivity, temperature, pressure, dissolved oxygen, and ph.

Table 2 - Profile of Respondents

The panel is well representative with three large groups (including Predict SME, an affiliate of SNEF), three medium-sized companies (MSC), and twelve SMEs.

They can roughly be categorised them into three categories:

- **Designers and manufacturers of Marine Autonomous Systems (MAS)** such as autonomous underwater vehicles (AUV) including those vehicles with propellers and/or buoyancy driven propulsion, remotely operated vehicles (ROV), and unmanned surface vehicles (USV). Nine companies in this field responded to the survey - 2 Groups, 2 MSC, and 5 SMEs. Most of these companies provide services in addition of selling their products.
- **Designers and manufacturers of marine instrumentation and data software**. Six companies in this field responded to the survey – 4 SMEs, 1 MSC, and 1 Group (SME affiliated). They sell their products and provide engineering solutions and services.
- **Providers of marine services**. Four companies responded to the survey. All of these companies are SMEs that provide their customers wit tailor made engineering solutions and operational services using MAS.

2.3.3 Data protection

According to the General Data Protection Regulation (GDPR), the GROOM II Project transparently inform survey respondents about how the data they are providing within the survey is collected and analysed.

The data collected through this survey is only used for the purposes of the GROOM II Project. It has only been shared with GROOM II Project Partners for the achievement of various tasks, including Association pour la Recherche et le Développement des Méthodes et Processus Industriels (ARMINES), Centre National de la Recherche Scientifique (CNRS), Helmholtz zentrum für ozeanforschung kiel (GEOMAR), Cyprus Subsea Consulting and Services C.S.C.S. Ltd., Universitetet i Bergen (UiB), National Oceanography Centre (NOC), Marine Institute (MI), Hellenic Centre for Marine Research (HCMR), Consorcio para el diseño, construcción, equipamiento y explotación de la Plataforma oceanica de canarias (PLOCAN), Pôle Mer Méditerranée (PMM), StratMar Conseil, Universidade do Porto (UPORTO), Ilmatieteen Laitos (FMI), Goeteborgs Universitet (UGOT), and Ecorys Nederland BV (ECORYS).

2.3.4 Analysis of the survey

The results and analysis of the survey is part of Deliverable D3.3. The analysis demonstrates that many companies within a range of industries expressed significant interest in joining the future GROOM RI. They define certain conditions to ensure a sustainable involvement of industry with the marine research infrastructure.

As directed by this survey, GROOM RI will be positioned on the ocean observation market. Other traditional markets such as defence and maritime surveillance as well as emerging markets such as renewable energy, deep sea mining, and other energy resources are very important to industry. Lastly, these areas of interest are supported by innovative marine technologies and, perhaps, may be at the heart of the future MRI: advanced automated navigation and planification of missions using AI, passive and active real time acoustic sensors and monitoring, and data acquisition and treatment.

These European companies interested in GROOM RI are worldwide leaders of marine autonomous vehicles and instrumentation. They are highly qualified suppliers of the RI and potential partners in the integration of engineering services, development of hardware and equipment, and maintenance of MAS. They have also expressed their expectations that the future RI will facilitate the showcasing of their products and services, increase of their client portfolio, and participation in and contribution to scientific studies.

GROOM RI will provide a cooperation framework to facilitate collaboration between scientists and industry to accelerate the development of innovative projects. These companies are open to broadening their network and improving the quality of their services through partnerships within the RI. Thus, GROOM RI may potentially play a central role securing the dissemination of information inside and outside the RI.

The survey is available in Annex 5.2 and titled “Expectations from industrials regarding the future GROOM RI”.

3. Market Feasibility Study

This section presents existing and emerging markets with the highest growth potential for GROOM RI. Each market is presented through three sub-sections:

- Market Description
- Geographical Dimension
- Estimated Market Evolution

Answers to the following questions from the survey inform this analysis:

- *1.2 - What could GROOM RI bring to your organisation?*
- *1.3 - How may GROOM RI promote your company?*
- *1.4 - What are your expectations when cooperating with other members & stakeholders of the RI?*
- *3.1 (To analyse the respondents interested in GROOM RI and the markets on which they are focused) - Would you be interested in being part of GROOM RI?*

The four markets analysed in this section have been chosen based on the consortium's learnings from the IAG-MAS Workshops, online survey, and internal research. Marine autonomous systems (MAS) are increasingly used for different sectors of the blue economy and a wide variety of purposes. The 2022 edition of the EU Blue Economy report identifies scientific research, surveys, oil and gas exploration, border surveillance (including defence and military use), infrastructure inspection, and farming as target sectors. Indeed, an increasing use of marine autonomous systems in industrial and commercial purposes enable ocean and underwater exploration in challenging environmental situations. In particular, MAS market applications are mainly for commercial exploration, defence, and scientific purposes. According to this report, "Underwater Robotics Market size was valued at $2,685 Billion in 2020 and is projected to reach $6,719 billion in 2028 (+ CAGR 12.15 % from 2021 to 2028)" (EU Blue Economy report 2022).

3.1 Analysis of European MRI landscape

The well-established operational RIs (Euro-Argo and EMSO) are firmly embedded in the scientific community. Since industries are only involved as suppliers, industrial users and private funding do not exist nor fervently sought.

However, emerging RIs like JERICO and EUROFLEETS + are more enthusiastically involving industry as users of their infrastructures. These RIs are still determining how to attract industrial users and in turn converting industrial use of their infrastructures into actual private funding. In other words, the existing projects and RIs close to GROOM II in the landscape do not offer much guidance on how to achieve financial sustainability when collaborating with industry.

The detailed analysis of the European MRI landscape is available in *D.3.3 Financial sustainability with industry.*

3.2 Applications of European Marine directives

3.2.1 Market description

GROOM RI potentially links to many maritime directives. The two main directives to be discussed include the Marine Strategy Framework Directive (MSFD) and Maritime Spatial Planning Directive (MSPD) which should always be understood in the context of the parallel provisions under the MSFD.

Marine Strategy Framework Directive

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 established a framework for community action in the field of marine environmental policy (also known as, Marine Strategy Framework Directive or MSFD) within which Member States are required to implement the necessary measures to achieve or maintain good environmental status (GES) in the marine environment by the year 2020. The MSFD further set an obligation to review this Directive by 2023 (Article 23).

For that purpose, marine strategies shall be developed and implemented in order to:

1. Protect and preserve the marine environment, prevent its deterioration or, where practicable, restore marine ecosystems in areas where they have been adversely affected.
2. Prevent and reduce inputs in the marine environment, with a view to phasing out pollution as defined in Article 3(8), so as to ensure that there are no significant impacts on or risks to marine biodiversity, marine ecosystems, human health, or legitimate uses of the sea.

Marine strategies shall therefore apply an ecosystem-based approach to the management of human activities. These strategies must ensure that the collective pressure of such activities is kept within levels compatible with the achievement of good environmental status. The capacity of marine ecosystems to respond to human-induced changes must not be compromised while also enabling the sustainable use of marine goods and services by present and future generations.

11 qualitative descriptors of GES have been developed that require **continuous monitoring of the marine environment** for the assessment and the regular update of targets.

Among the 11 descriptors of GES, almost all of them – apart from Descriptor 9 (contaminants in seafood) – may be more easily monitored with the direct utilisation of MAS as described below:

- Descriptor 1. Biodiversity is maintained
- Descriptor 2. Non-indigenous species do not adversely alter the ecosystem
- Descriptor 3. The population of commercial fish species is healthy
- Descriptor 4. Elements of food webs ensure long-term abundance and reproduction
- Descriptor 5. Eutrophication is minimised
- Descriptor 6. The sea floor integrity ensures functioning of the ecosystem
- Descriptor 7. Permanent alteration of hydrographical conditions does not adversely affect the ecosystem
- Descriptor 8. Concentrations of contaminants give no effects
- Descriptor 9. Contaminants in seafood are below safe levels
- Descriptor 10. Marine litter does not cause harm
- Descriptor 11 Introduction of energy (including underwater noise) does not adversely affect the ecosystem

A thorough review of how these descriptors may be monitored with AUVs using current and developing technology is provided in *GROOM II D4.3: GROOM RI contribution to statutory monitoring*. The following will provide a brief overview.

For descriptors 1 through 5, MAS can continuously measure the type and quantity of vegetal and animal marine biodiversity in the European seawaters. The implementation of gliders and AUVs equipped with high precision video cameras, photogrammetry, and the retention of water samples to extract e-DNA may greatly support the monitoring of Descriptors 1 through 5. MAS are geographically referenced with sufficient precision and can dive and stay underwater for extended periods of time. The potential application of mini AUVs deployed in fleets can cover large coastal areas and provide an extremely cost effective and time efficient solution to marine monitoring in comparison to traditional ship-based observation methods. Additionally, deploying MAS in this manner provides vast amounts

of data on the marine environment that is much richer in time and space than the 'snapshots' that ship-based monitoring delivers. The data collection and storage of huge quantities of data collected by the MAS is also part of this market.

Descriptors 6 and 7 require various sensors embedded on MAS to map the seabed and measure various hydrographic conditions. While Descriptor 8 requires potentially new methods as well as methods currently in development to identify the quantity and the nature of contaminants present in the sea and their potential effects on biodiversity.

As for Descriptor 10, the survey of marine litters could potentially be conducted by USV or AUVs. For Descriptor 11, ocean gliders have a tremendous advantage over other marine systems, because they are mobile (compared to buoys) and operationally quiet (compared to surface vessels or AUVs) – thus not disturb acoustic measurements during missions.

For most of these descriptors, ocean gliders have proven themselves to be useful platforms for monitoring (see D4.3 for evidence). The rapid development of small, low power sensors that can be easily implemented on ocean gliders and AUVs has highlighted the enormous potential of MAS to assist with ocean monitoring to directly address marine directives and legislation.

MARINE SPATIAL PLANNING DIRECTIVE

Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishes a framework for maritime spatial planning (also known as, Marine Spatial Planning Directive) aimed at promoting the sustainable growth of maritime economies, sustainable development of marine areas, and sustainable use of marine resources. Within the Integrated Maritime Policy of the Union, this framework provides for the establishment and implementation of maritime spatial planning by Member States.

Objectives of Maritime Spatial Planning

1. When establishing and implementing maritime spatial planning, Member States shall consider economic, social, and environmental aspects to support sustainable development and growth in the maritime sector, applying an ecosystem-based approach, and to promote the coexistence of relevant activities and uses.
2. Through their maritime spatial plans, Member States shall aim to contribute to the sustainable development of energy sectors at sea, of maritime transport, and of the fisheries and aquaculture sectors, and to the preservation, protection, and improvement of the environment, including resilience to climate change impacts. In addition, Member States may pursue other objectives such as the promotion of sustainable tourism and the sustainable extraction of raw materials.

Article 10 highlights the requirements of data use and sharing. It prescribes that Member States shall organise the use of the best available data and decide how to organise the sharing of information necessary for maritime spatial plans. The type of data can be environmental, social, and economic data collected in accordance with Union legislation pertaining to the activities referred to in Article 8 and marine physical data about marine waters.

The use of MAS to collect physical and biological environmental data is necessary. MAS have a host of benefits for persistent ocean monitoring programmes – from the carbon-free, electric propulsion of quiet and long-range buoyancy driven gliders and AUVs to their ease of deployment with small ships as opposed to the traditional alternative of large and loud surface vessels carrying ROVs to monitor the ocean.

3.2.2 Geographical Dimension

MARINE SPATIAL PLANNING DIRECTIVE

The MSPD shall apply to marine waters of Member States and without prejudice to other Union legislation. It shall not apply to coastal waters or parts thereof falling under a Member State's town and country planning if this is communicated in its maritime spatial plans. This Directive shall not interfere with Member States' competence to design and determine, within their marine waters, the extent and coverage of their maritime spatial plans. It shall not apply to town and country planning. This Directive shall not affect the sovereign rights and jurisdiction of Member States over marine waters which derive from relevant international law, particularly the United Nations Convention on the Law of the Sea (UNCLOS). In particular, the application of this Directive shall not influence the delineation and delimitation of maritime boundaries by the Member States in accordance with the relevant provisions of UNCLOS.

MARINE STRATEGY FRAMEWORK DIRECTIVE

MSFD shall apply to all marine waters as defined and shall take account of the transboundary effects on the quality of the marine environment of third States in the same marine region or subregion.

1. Member States shall, when implementing their obligations under this Directive, take due account of the fact that marine waters covered by their sovereignty or jurisdiction form an integral part of the following marine regions:
    - Baltic Sea;
    - North-east Atlantic Ocean
    - Mediterranean Sea
    - Black Sea
2. Member States may, in order to take into account, the specificities of a particular area, implement this Directive by reference to subdivisions at the appropriate level of the marine waters provided that such subdivisions are delimited in a manner compatible with the following marine subregions:
    - North-east Atlantic Ocean
        - Greater North Sea including the Kattegat and English Channel
        - Celtic Seas
        - Bay of Biscay and Iberian Coast
    - Atlantic Ocean
    - Macaronesian biogeographic region
        - waters surrounding the Azores, Madeira, and Canary Islands

- Mediterranean Sea
    - Western Mediterranean Sea
    - Adriatic Sea
    - Ionian Sea and the Central Mediterranean Sea
    - Aegean-Levantine Sea

We can observe that the market induced by the European marine directives covers all the European countries with coasts. It means that all the countries represented by partners of GROOM II are part of this market and will facilitate the access of this market to the future RI.

3.2.3 Estimated Evolution of the Market

Both directives are highly driven by environmental threats and climate impacts associated with the increasing demand for maritime space and resources from both traditional and emerging sectors. As such, their importance and scope are expected to increase, as well as the need for monitoring and assessment through harmonised high-quality ocean observation data and services provided by GROOM RI.

MARINE STRATEGY FRAMEWORK DIRECTIVE

The Commission adopted a report on the first implementation cycle of the Marine Strategy Framework Directive in June 2020. This report, required by Article 20 of the Directive, shows that while the EU's framework for marine environmental protection is one of the most comprehensive and ambitious worldwide, it needs to be 'beefed up' to be able to tackle predominant pressures such as overfishing and unsustainable fishing practices, plastic litter, excess nutrients, underwater noise, and others types of pollution. Furthermore, many MSFD reports submitted by member states highlight the absence of sufficient data as the cause for inconclusive assessments of descriptors. In the MSFD, it is further highlighted that the next step towards achieving good environmental status should be the establishment of environmental targets and monitoring programmes for ongoing assessment, enabling the state of the marine waters concerned to be evaluated on a regular basis.

MARINE SPATIAL PLANNING DIRECTIVE

In Europe, the 22 coastal Member States are obliged under the MSP Directive to develop a national maritime spatial plan (MSP) by 31 March 2021, at the latest, with a minimum review period of 10 years. Performance monitoring and evaluation is a key need for every MSP process, as well as the resulting maritime spatial plans to track the effectiveness of the measures, adapt to changes in environmental conditions and uses of the sea, and assess if the plans were "successful". The need for harmonised monitoring will increase now that all national plans are in place.

After two decades of talks that began in 2004, UN Member States have agreed on an International Treaty for the Protection of the High Seas, intended to "ensure the conservation and sustainable use of marine biological diversity in international waters."

Areas of the sea outside the sovereignty zones and exclusive economic zones of coastal states, and therefore outside national jurisdiction, are also referred to as high seas or international waters. The

challenge of the treaty is to achieve the ocean-related goals and targets of the 2030 Agenda for Sustainable Development and the Kunming-Montreal Global Biodiversity Framework, resulting from COP15. Generally, these goals and targets include:

- Fair and equitable sharing of benefits arising from marine genetic resources
- Creation of marine protected areas in order to preserve, restore, and maintain biodiversity
- Production of knowledge, technical innovations, and scientific understanding.

More specifically, the objectives of the treaty are:

- Definition of a regulatory framework
- Recognition of a common heritage of humanity
- Internationalisation of decisions on environmental impact studies

The application of the European directives in all European countries with coasts and the implementation of their action plans will constitute a sustainable market for GROOM RI, MAS, and data processing.

At the international level, the agreement on an international treaty for the protection of the high sea will increase the need of MAS worldwide. Ocean gliders will be particularly relevant because of their long-range capacity and endurance. They will be able to cover a huge surface to identify the biodiversity and cartography the seabed in the deep ocean. Another alternative will be to develop a fleet of deep mini AUVs (6000m) along with with small surface vessels. GROOM RI will play a key role facilitating this innovative development.

3.2.4 Example of Existing Application

The BIOGLIDER Project “Observing the oceans in coastal and deep offshore zones'' relies on coordinated deployments of various types of platforms equipped with multiple sensors. The ‘multiplatform’ approach is now recognized as the most relevant and cost-effective way to fully describe spatial and temporal oceanic variability for the needs of marine research, ocean observing systems (OOSs), and blue economy. Observing and monitoring biological communities – from plankton to fish – is still very challenging. However, it is essential to unveil complex ecological processes to ultimately allow adequate marine environmental protection measures and a more sustainable exploitation of the ocean.

Underwater gliders equipped with novel optical and acoustic imaging sensors can potentially play a significant role collecting and delivering ecosystem data, especially in extreme environments like the Arctic Ocean. Most of the technological building blocks to meet this challenge are available – from extremely low power sensors, ocean gliders, and software for control and analyses such as artificial intelligence (AI) algorithms. These various platforms, sensors, and software have been integrated and operated in coordination with other observing platforms to open new perspectives for comprehensive observations in coastal and deep seas. The BIOGLIDER Project addresses this scientific and technological challenge with an innovative and unique 'bioglider' integrated solution. Three smart devices – a vision profiler, scientific echosounder, and an acoustic modem – were integrated on commercially available ocean gliders to provide a ‘smart’ service for zooplankton and fish ecology applications. It was tested in the Nordic Seas and Arctic Ocean – thus meeting the needs of a wide

range of customers from research to the energy and fishery sectors. BIOGLIDER develops this innovative marine technology expertise in Europe through a strong, organised public-private collaboration, leading to the only commercialised solution for a glider-based ecosystem payload available worldwide.

Source https://bioglider.eu/

3.3 DEFENCE AND MARITIME SURVEILLANCE

3.3.1 Market Description

Defence and Maritime Surveillance are separate despite their close interconnections in many cases.

According to the last publication of the European Defence Agency (EDA), defence expenditure by the 26 European Defence Agency Member States rose in 2021 for the sixth consecutive year. The European Defence Fund (EDF), a dedicated funding mechanism launched in 2018, aims to strengthen the EU defence sector contributing to the technological sovereignty of the Union. While fostering competitiveness, efficiency, and innovation capacity in defence, the implementation of the EDF under the multiannual financial framework of the Union (2021-2027) will financially support consortia of companies from different member states undertaking cooperative defence research and development of defence products and technologies. The work programme targets 17 priorities including naval combat and underwater warfare.[1]

The future GROOM RI may bring expertise and technological solutions for defence application and needs, if not considering autonomous weapons such as torpedoes. The NATO Centre for Maritime Research and Experimentation (CMRE) of La Spezia indicates the relevent applications:

- Mine Hunting: The process involves finding, classifying, and destroying mines so they are no longer threats. Currently, AUVs are sometimes used to survey the seabed to detect mines. However, it still required for expert divers to be placed in harm's way to classify and destroy mines. When ROVs complete similar demining tasks, they are treated as expensive expendable devices. MAS, particularly AUVs, have the potential to offer a safer, faster, and lower-cost solution for mine classification and disposal. Autonomous surface ships and dedicated underwater MAS can be deployed to identify and then destroy mines.

  Classifying mines have historically been a time-consuming, resource-intensive process. There is a need to determine the feasibility of integrating high-resolution sonars with AUVs for mine classification in order to proceed to disposal. Automating the task of mine classification involves collecting multiple images of the mine and then fusing those images into a single image to classify with high confidence.

  An autonomous and cost-effective solution to dispose of mines is also an important application to develop. Typically, mine detonation weapons (MDWs) are guided by an ROV to the mine. These ROVs are treated as expendable subsea platforms despite their high cost. There is a real need to design and develop a cost-effective autonomous MDW with a minimal number of sensors and processors on board since it would depend on external support for guidance and control. A variety of options are being explored for transporting MDWs including AUVs and autonomous surface vehicles (ASVs).

[1] EU blue economy report 2022 https://defence-industry-space.ec.europa.eu/eu-defence-industry/european-defence-fund-edf_en

- Modelling and Simulation (M&S): M&S is a critical methodology with real value for NATO nations. M&S analyse the behaviours of both existing systems and hypothetical future systems in a range of simulated environments (Live-Virtual-Constructive). Traditionally used for training, this analysis can also be used to improve the understanding and performance of system and develop new concepts and technologies.

- Littoral Intelligence, Surveillance, and Reconnaissance. The advent of quiet diesel-electric submarines operating in shallow waters poses a challenge for anti-submarine warfare. Shallow waters, known as the littoral zone, are a particularly difficult area for sonar surveillance, because of the amount of noise and reverberation along the coast. Among different approaches, the development of multi-static active sonar may be a solution to finding and tracking the new generation of silent submarines.

  Today, sonar surveillance typically involves a ship towing an active sonar array with a transmitter and receiver. Known as monostatic sonar, this approach has particular limitations when tracking quiet submarines in shallow waters. A promising alternative to monostatic active sonar is multistatic active sonar, which involves multiple entities, or nodes, transmitting signals and receiving echoes in a coordinated effort to gain a more accurate view of the target. The nodes communicate with each other, and sophisticated signal processing software (i.e., data fusion) merge the data from all the different nodes. A multistatic system with both fixed sonar buoys and mobile sonar devices may be carried by an AUV.

- Environmental assessment: The success of military forces depends on understanding their operational environment and analysing that knowledge to make accurate decisions. In many cases, environmental knowledge is incomplete or contradictory, which can lead to poor operational and tactical decisions. The use of ocean gliders as low-risk, low-cost, covert data-gathering platforms has many advantages. A glider shifts its mass to change its trajectory and changes its buoyancy to generate propulsion. This platform can be used to gather near real-time data and adapts to the ever-changing requirements of the maritime environment. Capitalizing on advancements in IT and AUV technology, the main goal of NATO research is to develop automated tools and processes for the following three tasks:
  - Environmental characterization - uncertainty is assessed using a variety of mobile and remote sensors including satellite remote sensing and in situ sensing AUVs)

- Tactical prediction
- Decision making

Active sonar is essential to counter the threat of quiet submarines. In addition, it is necessary to include the means to detect the presence of mammals in operational areas to account for the effects of sonar on marine mammals. In summary, AUVs carrying hydrophones and associated information systems may be a beneficial solution to grant NATO military commanders the necessary tools for risk assessment and mitigation.[2]

The surveillance of EU waters is a diversified sector of activity – operated by both public and private actors covering not only the protection and safety of humans and goods during transportation but also environment protection and risk prevention. As such, it is a complex and fragmented economic domain. As a consequence, it is difficult to grasp in a quantitative and exhaustive manner. Nevertheless, surveillance of EU waters has grown significantly over the last decade. It was driven by technological developments expanding monitoring capacities and the continuous densification of activities and associated risks and impacts. More than 300 military and public civil authorities of EU member states perform all of these different tasks. Three European agencies including European Fisheries Control Agency (EFCA), European Maritime Security Agency (EMSA), and Frontex cooperate to support member state national authorities. They cover these sectors:

- Transport Safety and Maritime Traffic Support (including port and logistics infrastructure) – maritime search and rescue, ship casualty, and maritime assistance service operated by both national authorities (including navies, maritime affairs, customs, police, and port authorities) and increasingly by international private actors (shipping companies, data producers, and services providers).
- Maritime Security, Border Control and Migration – prevention and suppression of trafficking and smuggling essentially operated by national authorities (navies, maritime affairs, customs, and police) and sometimes in close relation with bordering countries (trans-national cooperation agreements)
- Fisheries Monitoring and Illegal Fishery Control – mainly operated by national and international fisheries institutions and private actors (data producers and NGOs). These activities rely on tracking technologies (AIS and Vessel Monitoring System [VMS]) and increasingly on satellite-based observation.[i]
- Detection and Response to Maritime Accident and Disaster – including marine pollution operated by national authorities (navies, maritime affairs, customs, and police) and involving mainly visual monitoring (both aerial and spatial). It is subject to international regulation (MARPOL) and completed at European (EMSA) and national levels.
- Observing Systems for the Marine Environment – often associated with marine research (more than maritime surveillance) using common technologies and infrastructures as well as serving

[2] Sciences & technology organisation/ Centre for maritime research & experimentation NATO https://www.cmre.nato.int/ https://op.europa.eu/en/publication-detail/-/publication/156eecbd-d7eb-11ec-a95f-01aa75ed71a1

common objectives. This includes monitoring habitats, species, water temperatures, water quality, pollution rates, and other elements.

As one of the achievements of the EU Member States, this work is supported by the European Commission and agencies in the framework of the European Union Maritime Security Strategy (EUMSS) and development of Common Information Sharing Environment (CISE). The European Maritime Security Agency (EMSA) aims to ensure a high, uniform, and effective level of maritime safety as security as well as prevent and respond to pollution caused by ships and oil and gas installations. The agency also contributes to the overall efficiency of maritime traffic and maritime transport.

The use of MAS in the field of maritime surveillance may include the following applications:

- Maritime security for port and ship protection and securing major events: The use of surface and underwater MAS can bring a level of permanent security at sea with marine patrol in and around the port (approach) and assure protection and detection of submarine threats directed against ships in the port or during major nautical events such as Olympic sailing.
- Maritime situational awareness particularly for border surveillance and controlling the presence of non-authorized vessels or underwater means in the EEZ of European countries: Compared to a conventional ship with seamen, ocean gliders, autonomous surface vehicles, and other MAS can cost-effectively and permanently patrol sensitive areas. They also have the capability to remotely send data and information to personnel on shore.
- Fisheries monitoring and halieutic resources assessment: an evaluation of resources accounts for and identifies high value marine species to impose fish catch quota to the fisheries, if necessary. Instead of utilizing large vessels with huge means and scientific experts on board, MAS could be valuable to monitor fisheries and improve assessments. The data collected may be pre-treated and sent remotely to the institutions in charge of this evaluation, thus saving costs and time.[3]

3.3.2 Geographical Dimension

Geographical dimensions in European sea basins are all of importance. In particular, sensitive areas in these basins are the Mediterranean, Baltic, and Black Seas.

The Mediterranean Sea is one of the world's busiest seas, and the geopolitical situation has been deteriorated considerably in the recent years due to the wars in nation-states like Syria and Libya as well as the considerable development of Islamist terrorism (Al Qaida, ISIS, and armed groups affiliated with them). This volatile dynamic weakens all the countries of the southern Mediterranean. Some nations are no longer able to control their territory and the flows that pass through them – a situation leading notably to a massive increase in the flow of refugees or economic migrants, development of illegal trafficking (narcotics, weapons, human beings, etc.), and an aggravation of the terrorist threat from territories under the effective control of armed groups.

Shared by Bulgaria, Turkey, Georgia, Russia, Ukraine, and Romania, the Black Sea is the largest enclosed sea in the world. It is the geographic gate between Europe and Asia. Since the end of the Cold War, it is also the maritime space which concentrated the greatest number of military conflicts: the Trans-Dniester War (1992), Abkhazia War (1992-1993), Georgian Civil War (1991-1993), wars in Chechnya

[3] European Fisheries Control Agency https://www.efca.europa.eu/en

(1994-1996; 1999-2000), Second South Ossetia War (2008), and Donbass - Crimea war which began in 2014 and continues following the Russian military invasion on the 24th of February 2022.

The Baltic Sea is an area of confrontation between the West and Russia. This sea is a strategic area due to the presence of the Nord Stream offshore pipelines which are the most direct connections linking the vast gas reserves in Russia with energy markets in the European Union.

Besides the European maritime basin, we must also account for the Exclusive Economic Zone (EEZ). With an area of of 25 million km² (before Brexit), the EEZ is the first in the world. Sovereignty must be maintained over these zones specially to control and protect halieutic and biological resources and the potential richness of the underground geology.

3.3.3 Estimated Evolution of the Market

According to the 2021 annual report of the European Defence Agency, the total defence expenditures of the 26 Member States amounted to €214 billion, marking the seventh year of consecutive growth. A record level of 24%, or €52 billion, was allocated to defence investments. Overall, there is a strong priority to procure commercially available equipment in most MS while less resources are dedicated to defence research and development. This could be further reinforced by the current security context.

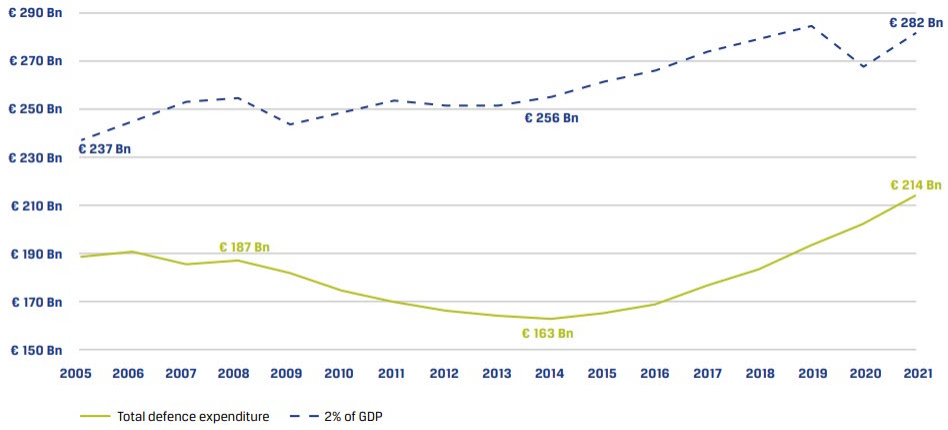


Figure 2 - European expenditures in Defence (European Defence Agency)

Following the Russian invasion of Ukraine, many European countries announced an increase in their defence budgets for 2023. For instance, France announced €400 billion for the army over the period 2024-2030 as well as a sharp increase in the military intelligence budget. Germany announced an increase of its defence budget by as much as €10 billion ($10.7 billion) in 2024. The 2023 NATO budget amounts to €1.96 billion (25.8% more than the 2022 budget).

The war in Ukraine generated considerable demand for weapons. Whether destined directly for Ukraine or European stocks, orders for weapons in 2022 increased as well. The European defence industry is facing difficulties meeting this increased demand. Member States' announcements following Russia's war against Ukraine signal that increases in expenditures will continue in the years ahead. Defence expenditures are estimated to grow further by up to €70 billion by 2025. These budgets could create favourable conditions for European cooperation on new defence capabilities.

In addition, the European Defence Fund is deploying €8 billion over the 2021-2027 period to support research and development projects that meet the needs of the armed forces – €2.7 billion for research

and €5.3 billion for development. The EDF budget represents a significant increase of the Preparatory Action on Defence Research (PADR) launched in 2017 by €90 million budget and the €500 million budget of the European Defence Industrial Development Programme (EDIDP) for 2019 and 2020.

The Fund places the EU among the top 4 defence research and technology investors in Europe. It acts as a catalyst for an innovative and competitive industrial and scientific base. Its main features are:

- Financing projects that help make the EU more secure and resilient and correspond to priorities agreed by Member States within the framework of the Common Security and Defence Policy (CSDP).
- Only collaborative projects involving at least 3 participants from 3 Member States are eligible.
- Development of common prototypes as Member States commit to buying the final products.
- Cross-border participation of SMEs and mid-caps is strongly incentivised by providing higher financing rates and favouring projects by consortia that include both SMEs and mid-caps.
- Targeting breakthrough innovation with up to 8% of the funds dedicated to disruptive technology and innovative equipment allowing the EU to boost its long-term technological leadership.[4]

After two decades of talks beginning in 2004, UN Member States agreed on an International Treaty for the Protection of the High Seas. The treaty is intended to "ensure the conservation and sustainable use of marine biological diversity in international waters."

High seas or international waters are areas of the sea outside the sovereignty zones and exclusive economic zones of coastal states. They are outside national jurisdiction. The challenge of the treaty is to achieve the ocean-related goals and targets of the 2030 Agenda for Sustainable Development and the Kunming-Montreal Global Biodiversity Framework resulting from Congress of Parties 15.

More specifically, the objectives of the treaty are:

- Definition of a regulatory framework.
- Recognition of a common heritage of humanity.
- Internationalization of decisions on environmental impact studies.
- Fair and equitable sharing of benefits arising from marine genetic resources.
- Creation of marine protected areas in order to preserve, restore, and maintain biodiversity.
- Production of knowledge, technical innovations, and scientific understanding.

3.3.4 Example of Existing Application

OCEAN 2020 is a €35 million collaborative project co-financed by the Preparatory Action on Defence Research mechanism – the first version of the current European Defence Fund. The project aimed to demonstrate a comprehensive “system-of-systems” open-architecture solution to the EU and European armed forces. The project included setting up a prototype representing the European Union Maritime Operations Centre to demonstrate sharing situational awareness at a European operational and strategic level. By being interoperable with national Maritime Operations Centres and achieving

[4] European Defence Fund https://defence-industry-space.ec.europa.eu/eu-defence-industry/european-defence-fund-edf_en

an integrated situational awareness, the European armed forces can better plan, safely operate, and task their deployed assets.

The project involved a large set of different actors, from public entities to industries, including prime contractors and SMEs. It achieved all the expected outcomes including two live demonstrations in the Mediterranean and Baltic Seas which involved 10 Member States' Ministries of Defence and navies.

In particular, the project has demonstrated the benefits of integration with various prototypes in real and simulated conditions. These ranged from a large set of unmanned system prototypes and their related innovative air, surface, and underwater payloads to cooperation and swarming considerations to situational awareness of key components such as the prototype for a European Maritime Operations Centre, not to mention prototypes of data integration, processing, and fusion.[5]

[5] OCEAN2020 project: https://ocean2020.eu/

3.4 Marine Renewable Energies: Offshore wind, Wave and tidal energy

3.4.1 Market Description

The EU is a global leader in Marine Renewable Energy (MRE). MRE includes offshore wind energy – both bottom-fixed and floating offshore wind turbines – and ocean energy – both wave and tidal energy. These technologies are at different stages of maturity. While large-scale commercial bottom-fixed offshore wind projects are already operating in Europe, large commercial floating wind projects have only recently come online. The EU industry is also a global leader in the development of wave and tidal energy technologies with 70% of the global ocean energy capacity developed by EU27 based companies. Although, the sector struggles to create an EU market according to the 2022 EU Blue Economy Report. Other promising ocean technologies such as salinity gradient energy and ocean thermal energy conversion (OTEC) are in the development stage. [6]

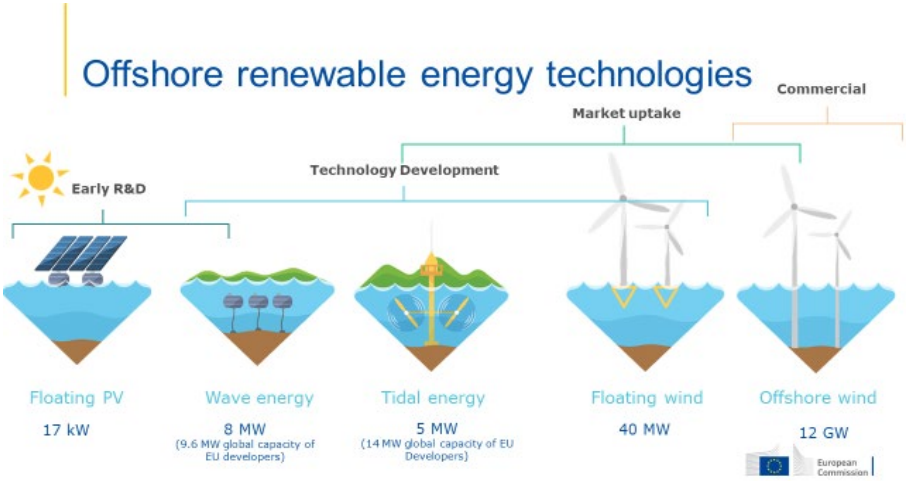


Figure 3 - Offshore Renewable energy technologies

This report focuses on offshore wind energy – both bottom-fixed and floating turbines. At the end of 2021, European sea basins were leading installed offshore wind energy with over 65% of the world's total installed capacity according to the 2022 EU Blue Economy Report.

This sector represents a significant source of green energy and is crucial for the EU to achieve the its carbon emission reduction targets for 2030 and climate neutrality by 2050. The EU27 offshore wind market represents 42% (12 GW) of the global market in terms of cumulative installed capacity, followed by the UK (9.7 GW) and China (6.8 GW). Moreover, European manufacturers - such as Siemens Gamesa, Vestas, and Senvion - produced 93% of the total offshore wind capacity installed in Europe (EU27 and UK) in 2019. Also, according to the the 2022 EU Blue Economy Report, EU companies face increasing competition from Asian companies with an increased deployment activity in China (more than 3 GW/year) and a "strong increase in the market share of Chinese OEMs (47%) – ahead of the European manufacturers (39%) when assessing their cumulative market share".

[6] REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL on progress of clean energy competitiveness {SWD (2020) 953 final}: https://www.europarl.europa.eu/RegData/docs_autres_institutions/commission_europeenne/com/2020/0953/COM_COM(2020)0953_EN.pdf

Created under the EU-funded ELBE EUROCLUSTER Project, the ELBE Alliance gathers eight Blue Energy clusters from eight key countries developing offshore wind energy in Europe: Spain, France, Sweden, Norway, Denmark, Belgium, Scotland, and Poland. This Alliance gathers all the members of these clusters representing more than 800 European stakeholders. This project provides accurate data about its members, the key players in each part of the value chains, on its website: http://www.elbealliance.eu/our-companies.

This new value chain of marine renewable energy including wind, waves, and tides can be categorised into seven main areas:

1. Project development and siting
2. Assembly and installation
3. Foundations
4. Design and manufacturing of converters
5. Grid connection
6. Operation and maintenance
7. Support and services

Among these areas, 1. Project development and siting, 2. Assembly and installation, 6. Operation and maintenance, and 7. Support and services concern the use of MAS.

- During the project development phase, MAS may be utilised for environmental assessment and monitoring. For instance, MAS can collect data about the nature of the seabeds and the characterisation of biological species.
- During the installation phase, MAS can help monitor and survey the process of anchoring as well as assist the establishment of dynamic electrical submarine cables and their connection to the main electrical substation. Various MAS could be beneficial such as AUVs and ROVs equipped with video, acoustic sensors and remotely manipulated arms.
- During operation, a continuous survey of the marine exploitation site will be necessary to guarantee the security and safety of energy production. MAS can efficiently and cost effectively survey these sites.
- Regarding maintenance, MAS can monitor and clean the biofouling on the submarine structures and measure corrosion using non-destructive tests. In case of necessary intervention, MAS will also be useful to maintain vessels for major repair operations as well as the dismantling phase.
- In terms of support and services, fleets of MAS will be mobilised when necessary for each marine renewable energy commercial farm. Training people to use MAS will become a service to offer as well. The MAS could also prove to be useful at existing test facilities and those under construction in Europe (i.e., Open-C in France and ORE Catapult in the UK).

3.4.2 Geographical Dimension

With the largest maritime space in the world and a vast potential in its sea basins, the EU is in a promising position to install offshore renewable energy. Different developmental stages of offshore renewable energy technologies depend on the specificities of each sea basin such as their geological conditions.

With its shallow waters, the North Sea has widespread natural offshore renewable energy potential. It is one of the world's leading regions in terms of deployed capacity in offshore wind and has localised

potential for wave and tidal energy. Moreover, the North Seas Energy Cooperation (NSEC) gives the North Sea a significant political and governance foundation. (COM (2020) 741 final)

Similar to the North Sea, the Baltic Sea has a high natural potential for offshore wind energy and some localised potential for wave energy. EU countries are increasingly interested in the potential of the Baltic Sea exemplified by the creation of several strategies and initiatives (BEMIP, VASAB, HELCOM, EU Strategy for the Baltic Sea Region).

The Atlantic Ocean adjacent to the EU offers a significant potential for both bottom-fixed and floating offshore wind energy developments due to its natural geological conditions. Many wave and tidal energy demonstration projects are being developed by those Member States with solid political and governance cooperation. Indeed, the EU's Atlantic strategy identifies offshore renewable energy as a strategic sector for cooperation.

The Mediterranean Sea mostly has offshore wind energy resources and potential wave energy and localised potential for tidal energy resources. The Barcelona Convention (regarding the environment) and the WestMed initiative organises regional cooperation to develop offshore renewables.

The Black Sea also has promising natural conditions for both bottom-fixed and floating offshore wind energy developments and localised potential to harness wave energy. The Common Maritime Agenda for the Black Sea fosters regional cooperation, and the Black Sea Strategic research and innovation agenda supports offshore wind and wave technologies.

EU islands should also be considered since there is vast potential to create offshore energy developments. They have attractive testing and demonstration grounds for innovative offshore electricity generation technologies and a long-term cooperation framework to promote replicable and scalable projects because of the Clean Energy for EU Islands Initiative. Lastly, European outermost regions and overseas have a high potential for offshore renewable energy.[7]

[7] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0741&from=ENSource: JRC (2019) Wind Energy Technology Market Report, JRC118314: https://publications.jrc.ec.europa.eu/repository/handle/JRC118314

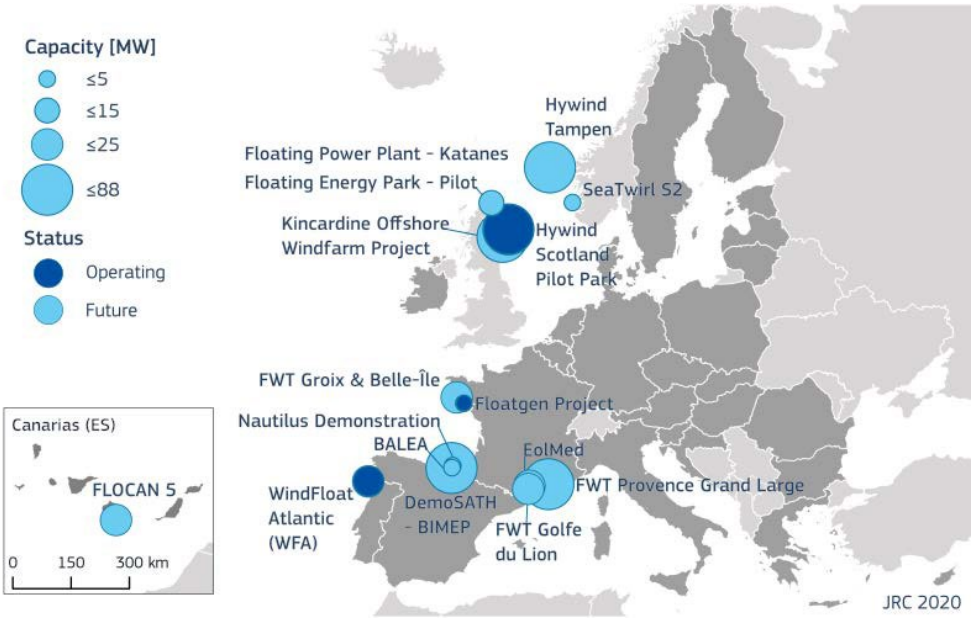


Figure 4 - Location of European floating offshore wind farms and large demonstration projects (≥1MW) (announced and operational, as of December 2019) Source: Wind Energy - Technology development report - JRC (Joint Research Centre), 2020 EUR 30503 EN

The EU's offshore wind industry is leading the sector with its home market reaching about 46% of the worldwide capacity deployed. The EU installed capacity is mostly located in the North (84%) and Baltic Seas (15%). The UK is the country with the largest installed capacity of offshore wind energy in European waters, with 10.3 GW) (The EU Blue Economy report 2022). The Member State with the largest installed capacity of offshore wind energy is Germany with 47%, followed by the Netherlands with 23%, Denmark and Belgium both with 14%. Finland, Sweden, France, Spain, Ireland and Portugal are increasing their installed capacity and will have even more in the coming years.

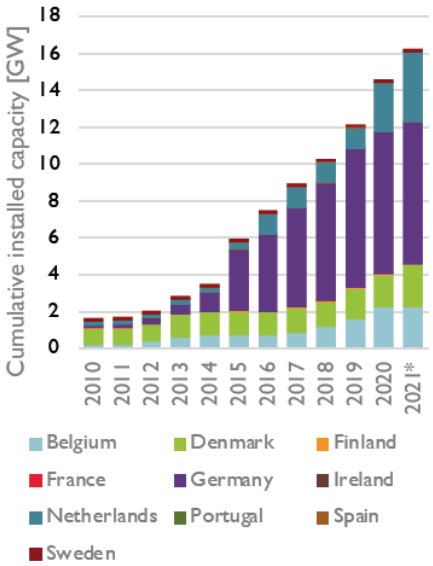


Figure 5 - EU offshore wind energy installed capacity, GW - Source: EU Blue Economy Report 2022 p73, JRC based on, GWEC, WindEurope, 4COffshore

3.4.3 Estimated Evolution of the Market

The EU currently is a global leader in offshore wind manufacturing with a total installed offshore wind capacity of 16.3 GW across 10 countries. As a first mover in the offshore sector, the EU's first offshore wind farm was installed in Denmark in 1991. In late 2021, 1.8 GW of new capacity was added to the grid (EU Blue Economy Report 2022).

The EU Offshore Renewable Energy Strategy is targeting at least 60 GW of installed offshore wind capacity by 2030 and up to 300 GW by 2050.[8] To achieve such goals, a massive paradigm shift is necessary in less than 30 years to multiply the capacity of offshore renewable energy by nearly 30 fold by 2050. The corresponding estimated investment is up to €800 billion.[9] An increase in the development rate will require all stakeholders, including MAS manufacturers, operators, and researchers to sustain this change in pace and help overcome any potential obstacles.[10]

MAS will be essential to this enormous future offshore renewable energy market to save time and financial resources during the offshore site surveys, installations, operations, and maintenance.

Advantages of MAS

- Potential permanent presence at sea with aid of smaller ships
- Reduced need for big naval ships, if not, eliminating large ships, altogether
- Capacity to be remotely controlled, operated, and reprogrammed
- Capacity to communicate and send data directly from the operation site without requiring recovering MAS
- Capacity to pre-treat data on board the autonomous platform thus optimising operation

With rapidly increasing installation of wind farm technology in European waters, ocean gliders are proving to be valuable tools for monitoring the ecological impact of offshore wind farm structures. Part of the Physics-to-Ecosystem Level Assessment Impacts of Offshore Windfarms (PELAgIO) Project demonstrates how ocean gliders equipped with a various suite of sensors directly measure how the implementation of wind farms in the North Sea might impact mixing and the distribution of phytoplankton. The impact of wind farms on phytoplankton in turn affects the feeding behaviour of larger marine predators.

According to the Realistic Expectations Scenario made by WindEurope, 27.9 GW of offshore wind capacity will be installed in Europe between 2022 and 2026 -- mostly in UK waters (39%). 2026 will be a crucial year.

The future RI will greatly benefit this growing market by designing and developing MAS adapted to the specific needs of the offshore energy market. The RI can also develop, certify, and integrate new sensors for this market. Members of the RI can also operate and maintain MAS, in addition to offering specific training courses to other stakeholders in the offshore energy industry.

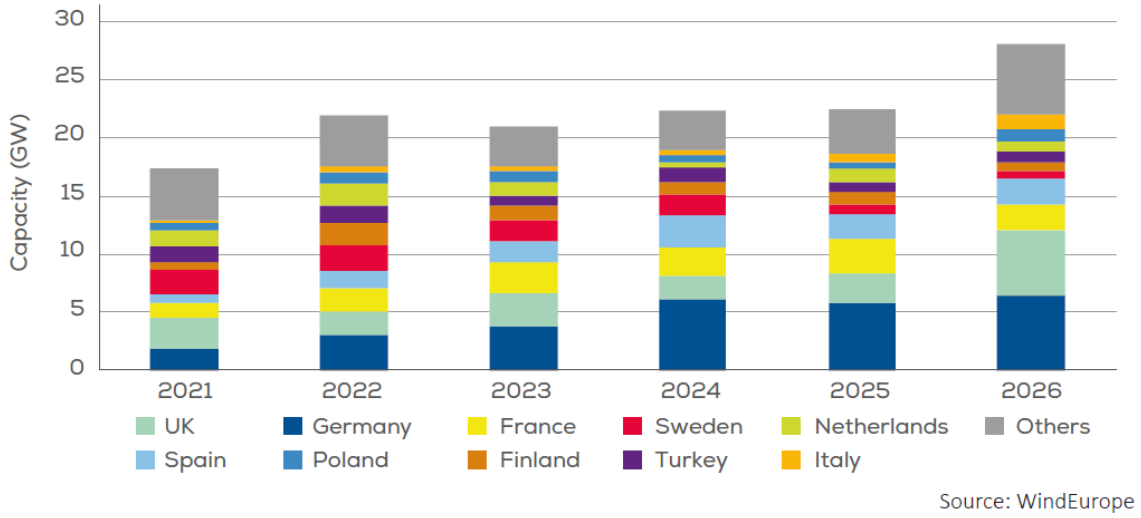
[8] European Commission, Directorate-General for Maritime Affairs and Fisheries, Joint Research Centre, Addamo, A., Calvo Santos, A., Guillén, J., et al., The EU blue economy report 2022, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2771/793264

[9] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0741&from=EN

[10] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0741&from=EN

FIGURE 16

New installations per country – WindEurope's Realistic Expectations Scenario



Source: WindEurope

Figure 6 - New offshore wind installation per country

3.4.4 Example of existing application

The SEACAT-ICCS project – led by French company SUBSEATECH – aims at developing a smart system for lightweight hybrid marine and underwater inspection drones. SEACAT is a 6.8m long surface drone designed for offshore missions. It is capable of deploying an inspection class ROV down to a 300 meter depth. With a payload of 250 kg and an autonomy of 7 days, it can carry out missions such as inspecting offshore infrastructures, monitoring of pipe laying, and surveillance.

3.5 Deep Sea Observation and potential exploitation

The deep sea is defined as the area at a depth where light begins to dwindle – typically around 200 meters and below. The deep sea observation market is involved in exploring and studying these vast and largely unexplored areas. Technologies developed and deployed to observe the deep oceans include submersibles, remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), and sensors that observe and collect data on the deep sea environment. Marine autonomous systems (MAS) and other associated advanced technologies are critical to understanding and protecting global oceans as demand for natural resources increases. The development of these new technologies is meeting the growing need to observe, explore, and potentially exploit the deep seas.

The deep-sea observation market has been growing recently to serve multiple industries and disciplines. From fisheries and aquaculture to oil and gas exploration and exploitation to deep sea cable surveying and laying, mining, and biotechnology, deep sea activities involve many complex issues with various political, economic, social, technological, and environmental dimensions. Companies serving these sectors offer a range of products and services including deep sea exploration and surveying, underwater mapping, and data analysis. We aim to provide an overview of this growing market, its socioeconomic implications, and the current developments in MAS serving these markets.

3.5.1 Market Description

Owing to the complexity of deep sea activities, deep sea exploration and exploitation involves maritime law, territorial claims, and international cooperation. The timing of the GROOM II Project and the writing of this deliverable are opportune as they coincide with a significant effort put forward by the UN to regulate the exploration and exploitation of the High Seas. The High Seas Treaty of the United Nations Convention on the Law of the Sea (UNCLOS) establishes the legal framework for the use and protection of the world's oceans including the deep sea. UNCLOS includes important elements such as the environmental assessment of some possible impacts from proposed activities, management tools including marine protected areas, marine genetic resources, capacity building, and the transfer of marine technology.

Fisheries & Aquaculture

According to the current UNCLOS, flag states hold the responsibility of regulating fishing practices. However, these states are obligated to collaborate with each other to conserve marine living resources in the high seas. They must also establish suitable management strategies when their nationals exploit comparable or diverse resources in the same region. Additionally, states are encouraged to establish regional fisheries organisations when deemed appropriate.

MAS may be deployed to monitor environmental conditions and fish health at aquaculture and fishing sites as well as provide real-time data on water quality and other parameters. They are a cost- effective means of communicating with static sampling devices. For example, the NOAA Coastal Ocean Science and Southeast Fisheries Science Center led an effort to collect high quality plankton data by integrating an Acoustic Zooplankton and Fish Profiler (AZFP) with an ocean glider. In another recent development, INNOVASEA, a major open sea aquaculture service provider, utilised glider technology to retrieve data from underwater passive acoustic station that collects fish migration data. The use of MAS significantly lowers costs contributing to the better management and sustainable production of food. This information can help farmers make informed decisions about feeding, stocking, and disease management.

Deep Sea Mining

Although there are still unresolved issues regarding deep-sea mining, the International Seabed Authority developed the Mining Code, a set of regulations and recommendations for the exploitation of deep-sea minerals.

Deep sea mining is the process of extracting minerals and metals under the sea floor including nickel, cobalt, manganese, and zinc. The mining process occurs at a depth of more than 500 metres. The deep-sea mining equipment and technology market is divided into three types -- polymetallic nodules, polymetallic sulphides, and cobalt-rich crusts. As for services, deep sea mining is classified into exploration and extraction. In terms of revenue, the exploration segment led the market in 2020. As for type, the polymetallic nodules segment dominated the deep-sea mining equipment and technologies market in 2020 in terms of revenue. While, the mining equipment market is divided into seabed mining crawlers, riser systems, and others.

Despite the economic benefits of exploiting deeper waters, there are still several barriers to entry. Costs associated with deep-sea exploration and exploitation can be high including the required significant financial investments to develop the necessary technologies and infrastructure. Such activities require advanced technology and infrastructure including underwater vehicles, remote sensing equipment, drilling rigs, and processing facilities. The development of these technologies is ongoing. Significant investments are required to bring them to fruition.

Deep sea activities could significantly impact the environment including the destruction of fragile ecosystems, disturbance of seafloor sediment, and potential release of pollutants into the ocean. Marine biodiversity disruptions and the loss of undiscovered species is also another risk. As such, there is a growing emphasis on ensuring that deep-sea exploration and exploitation are carried out in an environmentally sustainable and responsible manner with a focus on minimizing impacts and preserving the unique ecosystems that exist in the deep sea.

Advancements in technology and innovation in platform and sensing systems could enable MAS to become an essential tool for deep sea industrial applications. Advancements in sensing technology could include chemical sensors, water samplers, eDNA profiling, imaging device, and sound devices (BIOGLIDER Project). Ocean gliders may need to be improved to withstand pressure and reach greater depths (BRIDGES Project). Advancement in processing and data transmission is also an essential application that require real time data.

MAS technology can contribute to the sustainable development of deep sea operations throughout their design, implementation, operation and decommission.

Long range cables

The energy crisis and demand to continuously improve telecommunication capabilities have increased investments in underwater cables. Underwater cable connections are available between continents and major nodes. Their integrity and safety could be monitored by MAS technologies. Ocean gliders and AUVs launched from small support vessels are able to store data and communicate with ships or through permanent docks and recharging station implanted on the seabed.

Biological resources

Pharmacological, cosmetic, and other substances have been derived from marine life while marine biodiversity is greatly underestimated. Thus far, there are hundreds of thousands of known marine species. Although, a recent study estimated that there may be about a million marine species hence increasing the geographical extent of exploration for these compounds.

Steps Toward the Sustainable Development of Deep Sea Operations

1. Capacity development and knowledge sharing
2. Generation of ocean data
3. Building ocean understanding
4. Increasing use of ocean knowledge

GROOM RI will be in a prime position to assist with the collection of marine information required to achieve these objectives. GROOM RI will bring together MAS technology providers, operators, and data users to expand our understanding of these rarely studied ecosystems. In addition, GROOM RI will promote knowledge sharing through continuous training and dissemination.

Compared to costly marine observations with research vessels, MAS offers a low-cost data collection option that can provide baseline oceanographic and biological information of the existing ocean conditions.

3.5.2 Geographical Dimension

Although recent efforts were made to coordinate and combine activities, deep sea sectors often have contrasting goals and compete for marine space. In this section, we cover the markets available for deep sea services and deep sea regions that provide them.

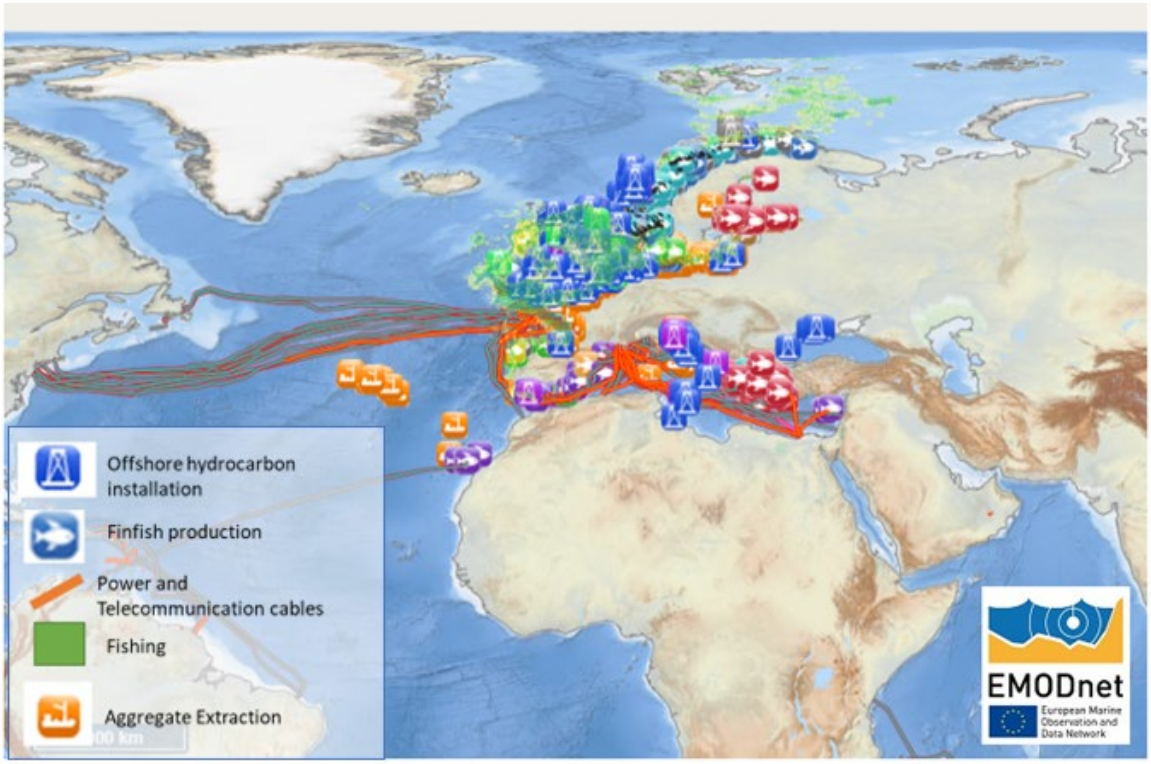


Figure 7 - Human activities in the deep sea. Map produced with data submitted to the EMODNET network (https://emodnet.ec.europa.eu/geoviewer/)

Deep sea operations are expanding as marine autonomous system technologies improve and the need for resources increase. Figure 7 (above) shows an overview of human activities and installations pertinent to the European area.

The Baltic Sea is a heavily impacted area with multiple stressors including fishing, hydrocarbon exploitation, and aquaculture. However, average depth is low at 55 metres. While its deepest point is in the pit of Lansort at 459 metres. Despite great interest, the Baltic Sea is not a target for deep sea MAS. With a depth between 50 and 100 metres, the North Sea is also not target area for deep sea MAS Although, it is possible that the North Sea along the Norwegian coast with depths between 200 and 700 metres may be more promising.

Fishing and aquaculture are the main activities recorded in the Barrent Sea with an average depth of 230 metres. Scientific observation could be of interest in those areas with depths of 200 metres and below. The deep sea market is not concerned with the channel due to its shallow depth (with the deepest point at 170 metres).

With an average depth of 1500 metres, the Mediterranean Sea is of great interest to deep sea observers because of its great depths close to its coastlines. Deeper spots are close to the Greek coasts in the economic exclusive zone of Greece – especially in the Ionian Sea, Calypso Pit with a depth of 5267 metres, and Mapan Pit with a depth of 5121 metres. National, European and international policies address the fisheries, aquaculture, scientific observatories, oil and gas exploitation, and long range cables in the Mediterranean Sea. Twenty two independent states share this strategic sea.

Despite the continental shelf, the North Atlantic Sea floor is rarely under 200 metre depths. Activities in this area are scientific sea bottom observation, aggregate extraction, installation, survey and maintenance of submarine cables, and marine renewable energy developments. Further from the coast, mining is expected to be an emerging activity in the North Atlantic owing to the estimates of available mineral deposits.

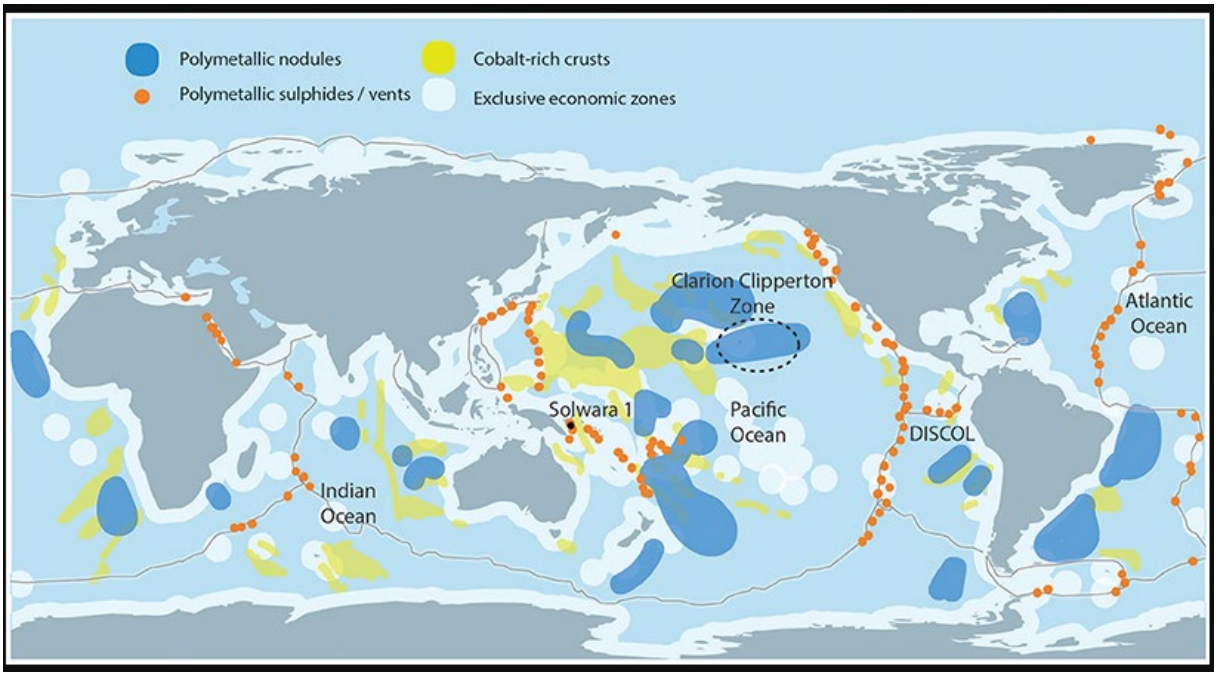


Figure 8 - A world map showing the location of the three main marine mineral deposits: polymetallic nodules (blue); polymetallic or seafloor massive sulfides (orange); and cobalt-rich ferromanganese crusts (yellow) (Miller et al., 2018)

3.5.3 Estimated Evolution of the Market

Driven by an increasing demand for raw materials, the European Union identifies deep-sea mining as one of the potential new blue growth sectors (ECORYS, 2012). Rare earth elements (REE) are used in a wide range of consumer products including smartphone screens, batteries, and magnets. REE are also important in many 'green' carbon-reducing technologies such as photovoltaics, fuel cells, and wind turbines. Their demand is growing at a rate of 5-10% per year with China currently dominating the supply at around 95%.

After two decades of talks that began in 2004, UN Member States agreed on an International Treaty for the Protection of the High Seas that is intended to "ensure the conservation and sustainable use of marine biological diversity in international waters." Again, high seas or international waters are areas of the sea outside the sovereignty zones and exclusive economic zones of coastal states under national jurisdiction. The challenge of the treaty is to achieve the ocean-related goals and targets of the 2030 Agenda for Sustainable Development and Kunming-Montreal Global Biodiversity Framework resulting from COP15.

- Fair and equitable sharing of benefits arising from marine genetic resources
- Creation of marine protected areas in order to preserve, restore, and maintain biodiversity
- Production of knowledge, technical innovations, and scientific understanding

Objectives of the Treaty

- Definition of a regulatory framework
- Recognition of a common heritage of humanity
- Internationalisation of decisions on environmental impact studies

According to Allied Market Research, the deep sea mining equipment and technologies market size was valued at $811.9 million in 2020 and is expected to reach $72,814.2 million by 2030 – registering a CAGR of 61.4% from 2021 to 2030. A driving factor of the deep sea mining equipment and technologies market share is the discovery of metals and mineral deposits under the seabed. Since the need for electronic components is ever growing, the markets for metals such as copper, nickel, aluminium, manganese, zinc, lithium, and cobalt are also increasing. Due to depleting terrestrial deposits of these metals, industry is searching for new sources. Cobalt-rich crusts market segment is expected to witness growth at the highest CAGR during this forecast period.

As Allied Market Research has indicated in their report, deep sea mining is considerably new and ripe for research and development. However, due to the COVID-19 outbreak, mining, manufacturing, and transportation activities along with their supply chains were blocked or restricted. As such, growth of the deep sea mining equipment and technologies market was hampered globally and is still recovering. Extraction segment is anticipated to register highest CAGR during the forecast period of 2021 to 2030.

Also, with the introduction of the Internet of Underwater Things (IoUT), interconnected smart subsea equipment – such as physical devices and sensors in remote locations – will be a major growth opportunity for the deep sea mining equipment & technologies market during the forecast period.

The biotechnology industry is now starting to explore deep water biota. Even after discovery, only a small number of products with marine genetic resources find their way onto the market with just seven recorded in 2019. The value of potential royalties has been estimated at $10 million to $30 million a year. New technologies and changes in regulation are expected to be a driving force in this market.

3.5.4 Example of Existing Application

The European Project Bringing together Research and Industry for the Development of Glider Environmental Services (BRIDGES) aimed at developing a deep sea glider based on the improvement of the SeaExplorer.[11] This platform was greatly improved – adapting it for deep basins (up to 5000 m) and implementing a novel payload architecture. This architecture increases autonomy and accommodates the range of sensing capabilities needed by integrating the associated control support system for single and networked operations (i.e., mission behaviour, data management, planning, and communications). The glider's sensing capabilities were also enhanced since the main modules allow for environmental monitoring and facilitating the effective implementation of an ecosystem-based management under the Marine Strategy Framework Directive. These sensing capabilities may also be beneficial to the oil and gas industry as well as the deep sea mining industry. To achieve the technological objectives and service requirements, an open dialogue between stakeholders will need to be developed.

The BRIDGES Project was ground-breaking because it provided a technology to enable long-term deep-sea monitoring on networked, unoccupied platforms. The long-term networking concept cannot be fully developed by current ROV, AUV, and HOV technologies due to economic and/or endurance limitations. BRIDGES further developed underwater gliders to provide a cost-effective, long-term, and easily networked capacity to monitor 98% of the world's oceans.

Gliders that the BRIDGES Project developed go beyond the capabilities of current glider technology since they can operate in extreme pressure environments with hybrid buoyancy and propeller propulsion navigation to facilitate seabed and ocean column exploration. The project also developed service-oriented smart sensing systems targeting industrial applications. The sensing systems are miniaturized, low-power systems suitable for glider operations and include cutting-edge technology for in-situ analysis of nutrients, acoustic characterization of the seabed, and small particle and organism imaging.

[11] https://cordis.europa.eu/project/id/635359/fr

4 Positioning GROOM RI on the Target Markets

Consultation with key stakeholders guided the analysis conducted by GROOM II partners to ensure that the future GROOM RI will target keys markets. Two complementary means -- both the Industry Advisory Group for Marine Autonomous Systems (IAG-MAS) and an online survey uncovering the expectations of key industry players – provided the data to develop this analysis.

We have identified four main markets GROOM RI should target:

- Applications to Meet European Marine Directives
- Defence and Maritime Surveillance
- Marine Renewable Energies (MRE): Offshore Wind, Wave, and Tidal Energy
- Deep Sea Observation and Potential Exploitation

While all of these markets are already existing, two of them are relatively new – European Marine Directives and Marine Renewable Energies markets. Marine autonomous systems have demonstrated their tremendous potential to collect the necessary biological, physical, and other environmental data necessary for these main markets.

Also, the defence and maritime surveillance and deep-sea observation markets have been known for several years. Considering the fraught geopolitical and economic context, these two markets will develop into strategic issues in the coming decades.

To fulfil these different markets, GROOM RI should be able to propose a panel of solutions and its extensive expertise to industry and public bodies.

We can consider two approaches:

Shallow Waters Markets

For the Marine Renewable Energies (MRE) and Applications of Marine European Directives markets, MAS are required for coastal applications in shallow waters. MAS that can be deployed in shallow waters (less than 200 m) with medium autonomy (around 24 hours or less) are necessary. The main goal is to collect environmental and biological data with MAS and treat these datasets for the end users. The solutions MAS can provide will answer the public and industry's needs. Currently, GROOM II Partners own and operate various MAS platforms, sensors, and data servers. In addition to this important equipment, GROOM II partners also have the critical expertise and networks to more easily organize the data to deliver to external parties.

Deep Sea Markets

The Deep Sea market needs including the exploration and, eventual, exploitation of the deep sea as well as the defence and surveillance issues of EEZ and high sea require more sophisticated systems and fleets of MAS. Deep sea gliders in development now will be part of the solutions addressing this market. GROOM Partners have the knowledge and competencies to collaborate with European companies designing, manufacturing, and delivering autonomous platforms, innovative sensors, and data processing to serve both European scientists and industry to collectively become leaders of this emerging market.

The future GROOM RI will establish strong relationships by linking industry and scientific stakeholders and sharing resources including infrastructures, vehicles, data, and know-how thus leading to new public-private partnerships.

5 Annexes

5.1 Industrial Advisory Group Maritime Autonomous Systems (IAG MAS) workshops meeting minutes

5.1.1 Meeting minutes of the first Industrial Advisory Group Maritime Autonomous Systems, April 11, 2022

Welcome and agenda

Objectives of the workshop:

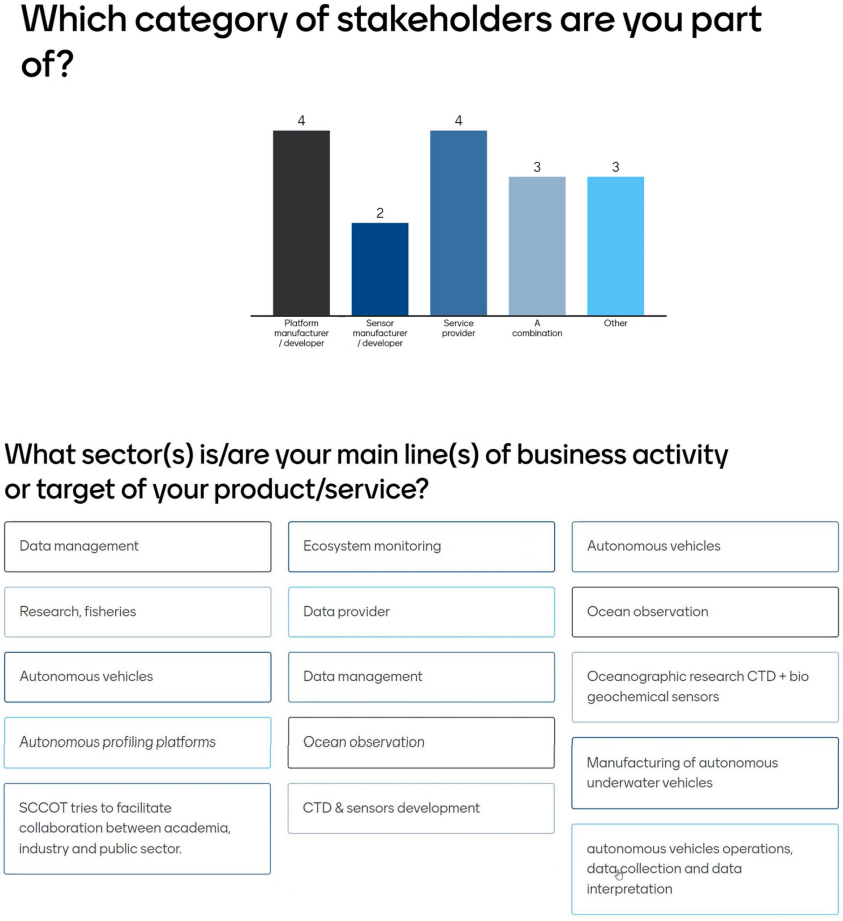
- Building collaboration and trust
- Identifying and describing commercial needs for services ad for innovation
- Ideas for potential examples of cooperation

In practice:

- Ice Breaker
- Concept of the GROOM Research Infrastructure
- Interactive discussion about environmental monitoring using MAS

Ice Breaker

Participants were well distributed among the different categories of stakeholders. Among the 3 “other” responses, one participant was a digital solution provider (data management and interpretation layer / deployment simplification layer).



Concept of GROOM Research Infrastructure (RI) and IAG-MAS

GROOM Research Infrastructure Concept

Groom RI is about making Ocean gliders and long-range autonomous systems widely accessible in large numbers to three categories of users:

- Research and academic users
- Observing systems and statutory monitoring
- Industry and beyond

GROOM RI VEHICLES

Ocean gliders, long range autonomous systems (gliders, surface vehicles, long range underwater vehicles) because they have unit characteristics (complex data sets, way of operating and managing those sets is different from a buoy or a ship).

GROOM partners currently represent 36 gliderports where gliders and surface vehicles are operated and can be accessed by the users.

VISION STATEMENT OF FUTURE RI

To be the leading European Research Infrastructure in the provision of high-quality ocean observation data and services for the benefit of society, enabling scientific excellence through harnessing the advantages of Marine Autonomous Systems (MAS).

MISSION STATEMENT

This European RI integrates national infrastructures for MAS to provide access to platforms and services and expertise to the broadest range of scientific and industrial users.

It maintains a unique centralized provision of cyber-infrastructure, data and knowledge for the optimized use of MAS to study climate and marine environments and to support operational services and the blue economy.

OBJECTIVES

As a formal entity, the RI will ensure cooperation, coordination, integration, and simplification to provide access to world-class marine autonomous services. The RI will:

- Connect scientists and industry with autonomous marine platform operators and integrators
- Support research, management, and blue economy (help create knowledge, technology, services)
- Ensure high value data production and good access to data which flows for societal benefits
- Guide technological development, best practices, frontier science and process studies

WHY HAVE A RI?

- Increased need and value for low carbon ocean observations
- Rapid rise of glider, long-range AUV and surface vehicle technology and near real time data availability
- New technological developments that enable effective and secure data sharing, data integration and data enrichment.

Added Value of the MAS Research Infrastructure:

- Reduce fragmentation of the research and innovation ecosystem
- Avoid duplication of effort
- Joint force to construct and run large, complex or expensive infrastructures
- Invite industries to the co-developments of new technologies, methods
- Use scientific collaboration to address common problems and build partnerships

- Serving the blue economy by offering opportunities to industries to develop, test, and demonstrate their products
- Respond adequately and timely to global challenges.

IAG-MAS Concept

OBJECTIVES

- Strengthen relationship between industrial & national/EU scientific & technical stakeholders
- Develop a cooperative framework between researchers & MAS service providers for GERI access
- Identify & advance priorities for innovation in developing new MAS and products & applications
- Exchange views on the industry's needs & the available assets & expertise in GROOM
- Most importantly, produce a set of inter-related outcomes for the emerging research infrastructure

EXPECTATIONS OF MEMBERS

- Involvement in designing the workshop agendas & highlighting key challenges to be addressed
- Identification & mobilization of key national & (preferably) European actors for these workshops
- Identification of frameworks for effective, sustainable operation in receptive industrial sectors
- Provide advice on financial targets & potential legal structure
- Identification of European funding opportunities related to priorities above
- Help Develop:
  - High-impact services for new & emerging markets in the Blue Economy
  - Environmental services for industries that benefit from marine robotic monitoring
  - Key societal benefits of a sustainable marine research infrastructure

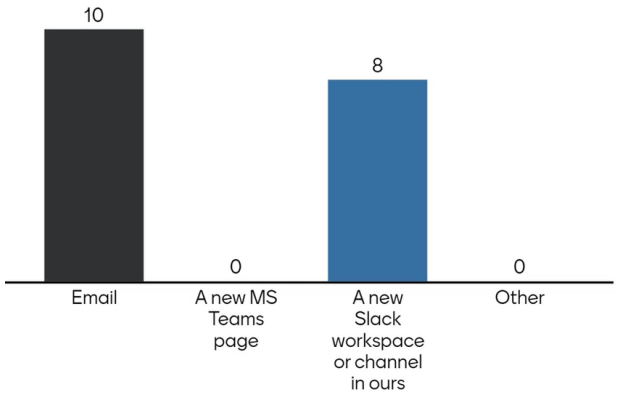
IN PRACTICE

Meeting schedule, format, and agenda:

- 3 virtual meetings, 2h each
- Roundtable offline through short biographies
- Agenda and minutes to be circulated to all members

HOW CAN WE BEST KEEP YOU UPDATED?

In accordance with participant's votes, a slack workspace will be created in GROOM II account. Communication via e-mail will be continued.



Discussion - Environmental Monitoring Services

QUESTIONS FROM THE IAG-MAS MEMBERS

"GROOM wants to suggest a way of handling the data from gliders and long-range autonomous vehicles which would be revolutionary because currently all the data is separated by data type. Does GROOM really intend to maintain the data on a long-term data base for data that comes from a certain platform?"

GROOM RI will not necessary be the one holding the database but may be the one helping to design the infrastructure or best practices that are needed for national and global centres to maintain those databases in a way that can be easily accessed by everyone.

Currently, we have platforms collecting different types of data, going to different repositories. The key thing we need to have within the RI is a central discovery mechanism so we can get to this data cleanly and easily.

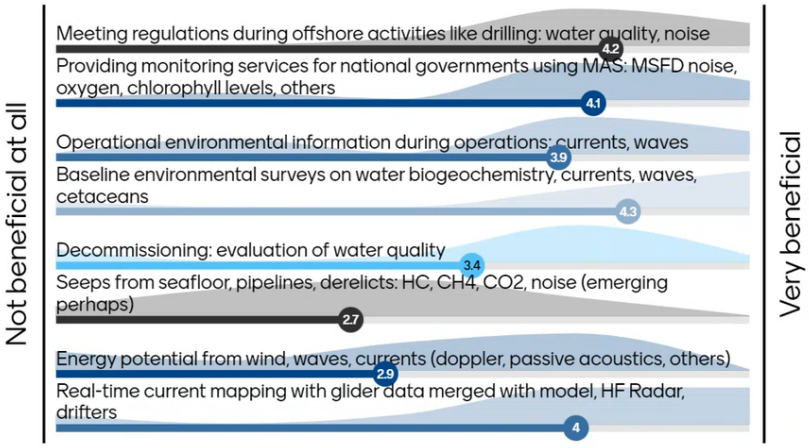
"GROOM is one of these large European infrastructures where you have a lot of gliders and skills across the value chain. Of course, you would like to bring this to the industry but what I often see with these large European infrastructures is that they miss to connect and work with the industry because often the industry needs very flexible and adaptive subcontractors. One of the questions is to answer is: do you have within GROOM this adaptability and flexibility and if not, can you develop this to answer the industry's needs."

We do not imagine GROOM as the one providing the service in fact. We want to help companies who need to move quickly and get asset and expertise matching their need. GROOM RI's role is more a facilitator role which is why we need feedbacks from the industry.

QUESTIONS FOR THE IAG-MAS MEMERS: ENVIRONMENTAL SERVICES FOR INDUSTRY'S NEEDS

- Does the standardisation done at the international level for science works for industry and if it does not work what differences do we need to implement to work better with industry and provide better data?
- What type of assistance the future infrastructure could offer to industries that carry out or support marine monitoring?
- What legal, administrative, or logistical "pain" is being alleviated or what value proposition does RI offer?

How beneficial would the following examples of services offered by the RI be for you / your organisation?



"What Dan has just said is that if there was private industry to offer certain types of observational services it would not be the RI to compete on these things. Now we talk about services that the RI would potentially offer. Shall we assume that the RI would handle the services that you do not find commercial partners to handle with?"

We want to assist the operators (IAG-MAS members, industry) to do the services, we do not want to compete. The services would be offered by the private industry supported by the RI.

"It is important to differentiate the raw data with all the meta information and then processed data which will be directly useful to these different topics. It would be very difficult to centralise the raw data because it is coming from different places and collected in different ways, but it might be interesting to be able to centralise the processed data so that there is a common access for stakeholders to use this data for their application.s."

Absolutely. When it comes to quality control data and processed data, it is important to have a data set that is accepted by the scientific community and thus by the authorities.

"National security rules around making measurements are an enormous hassle. Any unified support from GROOM here would be great."

It helps to have partners in different partners in different countries to have more chances of getting the permit. Do you have specific issues?

Sweden is a very unpermitting environment.

Lobbying with an international network could help

Could you elaborate on this RI concept?

We are targeting distributed infrastructures (mobile, not centralised with a building and staff). The cyber infrastructure might be centralised, but the physical infrastructure and expertise is around. The details are not yet finalised. Regarding the relationship between the RI and the industry, it is necessary. Industry is a provider of instruments and at the same time governments are asking us to be closer to the downstream part of the activities of companies and societies at large. Several mechanisms push us towards the industry.

Does the example have to be European? The US is ahead of the EU in terms of public private observation and use cases are merging

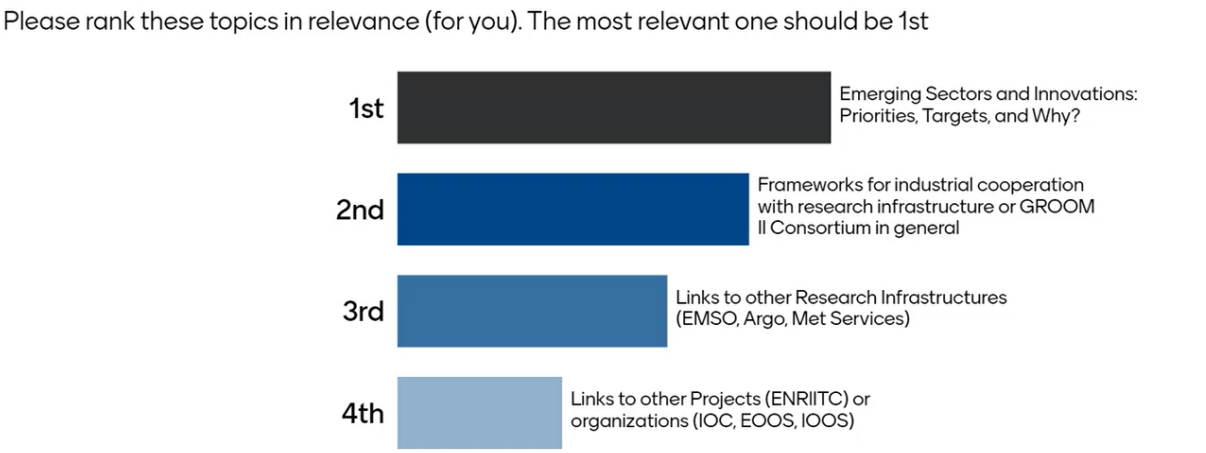
The US has a different approach, but the funding approach is also different in other words it's a national centralised funding whereas in Europe the only funding model that works is Member States contribution.

Next workshops (2 remaining)

What do you expect or would like to discuss in the next workshop?

Open comments and feedbacks:

- *Some individual interaction may help*



- *The legal aspects of MAS seem to be an outcome of this meeting*
- *Open slack channel to increase interaction, connexion*
- *"Working with industry" should be diversified and more clarified*

For more information, contact GROOM II WP 5 leader, Daniel Hayes, hayesdan@cyprus-subsea.com.

Participants

Organisation	Name	Surname	Category
Akvaplan-Niva	Lionel	Camus	IAG-MAS Member
Alseamar	David	Diaz	IAG-MAS Member
ARMINES	Laurent	Mortier	GROOM II partner
ARMINES	Kamil	SZAFRANSKI	GROOM II partner
ARMINES	Yves	Ponçon	GROOM II partner
Cyprus Subsea Consulting & Services Ltd	Daniel	Hayes	GROOM II partner
Cyprus Subsea Consulting & Services Ltd	Jerald	Reodica	GROOM II partner
ECA Robotics	Marc	BATTAIS	IAG-MAS Member
ECORYS	Charlotte	Lucas	GROOM II partner
HCMR	Evi	Bourma	GROOM II partner
Kongsberg Maritime	Peer	Fietzek	IAG-MAS Member
Liquid Robotics-Boeing	Francois	Leroy	IAG-MAS Member
Marine Institute	Kieran	Reilly	GROOM II partner
MRV	Katherine (Kasia)	Zaba	IAG-MAS Member
MRV	Fritz	Stahr	IAG-MAS Member
National Oceanography Centre	Justin	Buck	GROOM II partner
National Oceanography Centre	Alvaro	Lorenzo Lopez	GROOM II partner
NOC Innovations Ltd: Marine Robotics Innovation Centre	Daniel	Woods	IAG-MAS Member
Offshore Sensing AS	David	Peddie	IAG-MAS Member
PLOCAN	Andres	Cianca	GROOM II partner
Pôle Mer Méditerranée	Charlène	Aurégan	GROOM II partner
Pôle Mer Méditerranée	Colin	Ruel	GROOM II partner
RBR	Didier	Clech	IAG-MAS Member
BE	Thomas	Mitchell	IAG-MAS Member
SCOOT	Torsten	Linders	IAG-MAS Member
University of Gothenburg	Bastien	Queste	GROOM II partner
VOTO-Ocean Knowledge pillar	Olle	Peterson	IAG-MAS Member
Total : 27	14 consortium members		
	13 IAG-MAS members		

5.1.2 Meeting minutes of the second Industrial Advisory Group Maritime Autonomous Systems, June 14, 2022

Welcome and agenda

Objectives of the workshop:

- Building collaboration and trust
- Answering concerns from the previous workshop: what is the positioning of the RI? What is its role regarding industry - fostering cooperation or competition?
- Reach a priority list or consensus on most suitable Emerging Sectors and Innovations for MAS

In practice:

- Review the concept of the GROOM RI
- Ice Breaker
- State of the art MAS
- What are the priority emerging sectors for the RI?
- Which goals would you like the GROOM RI to set in order to meet your needs?
- Interactive discussion: emerging sectors and innovations

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- Connect scientists and industry with autonomous marine platform operators and integrators
- Support research, management, and blue economy (help create knowledge, technology, services)
- Ensure high value data production and good access to data which flows for societal benefits
- Guide technological development, best practices, frontier science and process studies

WHY HAVE A RI?

- Increased need and value for low carbon ocean observations
- Rapid rise of glider, long-range AUV and surface vehicle technology and near real time data availability
- New technological developments that enable effective and secure data sharing, data integration and data enrichment.

Added Value of the MAS Research Infrastructure:

- Reduce fragmentation of the research and innovation ecosystem
- Avoid duplication of effort
- Joint force to construct and run large, complex, or expensive infrastructures
- Invite industries to the co-developments of new technologies, methods
- Use scientific collaboration to address common problems and build partnerships
- Serving the blue economy by offering opportunities to industries to develop, test, and demonstrate their products
- Respond adequately and timely to global challenges.

It aims to serve the blue economy by offering industries to develop, test, and demonstrate their products and respond adequately and timely to global challenges.

OBJECTIVES OF IAG MAS

- **Strengthen relationship** between industrial & national/EU scientific & technical stakeholders
- Develop a cooperative framework between researchers & MAS service providers for GERI access
- **Identify & advance priorities for innovation** in developing new MAS and products & services
- Exchange views on the industry's needs & the available assets & expertise in GROOM
- Most importantly, produce a set of inter-related outcomes for the emerging research infrastructure

Ice Breaker

In your opinion, how could the RI be beneficial to industry?

RI BENEFITS FOR SENSOR MANUFACTURER & DEVELOPER

- An adaption and integration work can be done once and proper if used several times on the same platform
- The RI could provide access to test and demonstrate new sensors.
- 'Frontier' innovation in the field on mini/micro sensor development
- Understanding the needs of users in terms of sensor and/or system integration.

RI BENEFITS FOR SERVICE PROVIDER:

- They would benefit from a focus on access to data and to the decision process of how data are collected, i.e. co-designing data collection.
- Reduce cost investment

RI BENEFITS FOR PLATFORM MANUFACTURER & DEVELOPER:

- Offer ready-to-use state of the art infrastructures for launch and recovery of underwater & surface vehicles
- Deal with regulation for autonomous navigation of systems
- Adapting technology to user requirements
- Reduce the development time

OTHER

- Public authorities: avoid them to buy themselves the equipment they need

DISCUSSION:

- Where do you categorize the large industries, like O&G, DSM, ...?

We envision service providers to be the link to larger industries.

- What about standardization/best practices that a RI certainly would have to establish?
- Can you clarify the role of the RI and why would we use it?

GROOM RI will provide access to platforms, services and expertise, and our mission is in adequation with Europe to foster the collaboration between actors, and to connect scientific and industries to reach objectives.

For example, if you would like to use autonomous platforms and you are not sure who has what and who can help you, then the GROOM RI would find other people using this technology and give you access to the technology, to the expertise to use it or handle and analyse the data. This is a work in progress, and this is why we ask you what would be beneficial for you.

Concretely, GROOM RI could act as a knowledge base of the resources available in Europe.

- How can we make existing data available and in a more open way? Not only what has been collected in the past but also what is planned? It would be helpful to make it more generally available and for general purposes.

State of the art MAS

We suggested that IAG MAS members make a presentation on one emerging innovation sectors that they find particularly interesting.

Presentations from Andy Ziegwied (Ocean Data) and Dan Hayes (CSCS) are available in annex 1 and 2.

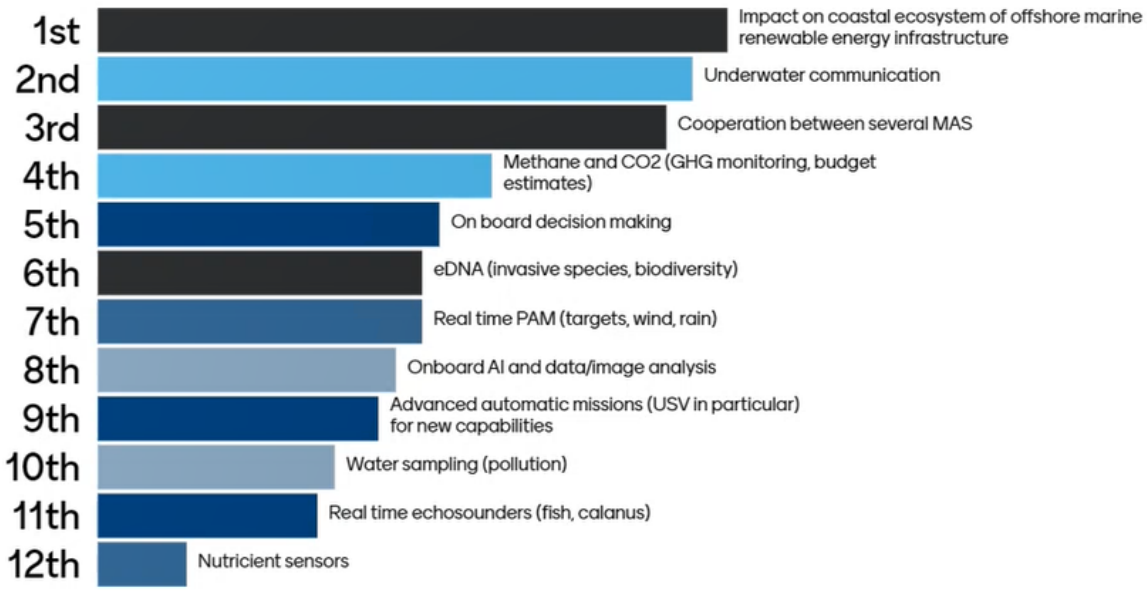
Discussion – Emerging sectors and innovations: priorities, targets and why?

Potential examples:

- eDNA (invasive species, biodiversity)
- Real time echosounders (fish, calanus)
- Real time PAM (targets, wind, rain)
- Water sampling (pollution)
- Methane and CO2 (GHG monitoring, budget estimates)
- Impact on coastal ecosystem of offshore marine renewable energy infrastructure
- Advanced automatic missions (USV in particular) for new capabilities

WHAT ARE THE PRIORITY EMERGING SECTORS FOR THE RI?

The discussion allowed to reach a list of the sectors we consider as a priority. According to participant's votes, the priority emerging sectors for the RI are:



- Impact on coastal ecosystem of offshore marine renewable energy infrastructure
- Underwater communication
- Cooperation between several MAS

QUESTION:

- How can the GROOM RI identify the milestones to monitor the progress?

We have to determine how we will measure the progress. The performance indicators could be the number of research papers, articles, global integration, new collaborations, …

WHAT GOALS DO YOU THINK SHOULD BE SET FOR THE GROOM RI IN ORDER TO MEET YOUR NEEDS?

- Facilitate cooperation between users to develop new demonstrators
- Identify the markets clearly to identify the RI's needs
- Recognize gliders (autonomous platforms) as important platforms (legally), alongside crewed ships
- Work on international acceptance for autonomous data collection platforms as non-military vehicles that can work in the EEZ
- Provide links or introductions to programs and/or observatories that use MAS and need new capabilities on those
- Offer a large set of MAS equipment that industrials companies could use to prove the interest of MAS to address several markets aimed (difficulties to find international standards, we should work to establish standards - where was the data collected? etc.)
- Set a "regulation-free" area for testing of autonomous vehicles
- Facilitate Cooperation between users to develop new demonstrators.

IDENTIFIED ISSUES:

- Recognized areas are needed to test AUV:

There is a necessity to create a unique system of autonomous data collection and identify recognized areas to test AUV. Rules are strict but some countries have already this kind of area in China, Norway, or Gran Canarias (Spain). In Spain, the National Agency for Maritime Issues is coordinating a working group on this topic and its links to the European initiative to implement the basis from the regulatory spectre. However, a lot of governmental and private stakeholders are involved, and it takes time to put it in action.

Renewable energy is clearly an emerging sector, and there is a lot of interest for the concerned country and the European Union and autonomous systems should play a key role for measuring what is happening and reduce cost.

- Lack of visibility on final targeted markets:

The market entrance seems to be done on technologies (that we have prioritised during the workshop), but technologies will be validated forwards the realisation of services linked with the market.

Monitoring marine pollution (like microplastics and drug molecules) became a major preoccupation all around the world and particularly in the Mediterranean Sea. All European States are concerned, and this topic will probably receive important funding in the next years. MAS economy is in a good position for growth.

Surveillance of Marine Protected Area (MPA) and marine parks are submitted to strict regulations but there is not enough control due to a lack of human resources. Marine autonomous systems will be part of the solution to ensure laws are respected in these areas. A functional board with technologies and markets will help us to accelerate our future actions.

Next workshops (1 remaining)

What do you expect or what would like to discuss in the next workshops? Any comments or feedbacks?

- Frameworks for industrial cooperation with research infrastructure or GROOM II Consortium in general *(3 answers)*
- Links to other Research Infrastructures and organisations such as the OOS's *(2 answers)*
- Conditions of coworking of competitors (for R&D of new products) within the same RI and all related privacy issues *(1 answer)*
- Cross the technologies identified as priorities with the existing and emerging markets *(1 answer)*

For more information, contact GROOM II WP 5 leader, Daniel Hayes, hayesdan@cyprus-subsea.com.

Participants

Organisation	Name	Surname	Category
Alseamar	David	Diaz	IAG-MAS Member
ARMINES	Laurent	Mortier	GROOM II partner
ARMINES	Kamil	Szafranski	GROOM II partner
Akvaplan Niva	Lionel	Camus	IAG-MAS Member
Cyprus Subsea Consulting & Services Ltd	Daniel	Hayes	GROOM II partner
Cyprus Subsea Consulting & Services Ltd	Jerald	Reodica	GROOM II partner
ECA Robotics	Marc	Battais	IAG-MAS Member
ECORYS	Charlotte	Lucas	GROOM II partner
ECORYS	Jessica	Dirks	GROOM II partner
Hefring	Atle	Lohrmann	IAG-MAS Member
Marine Institute	Kieran	Reilly	GROOM II partner
Marine Institute	Sebastiaan	Swart	GROOM II partner
MRV	Katherine	Zaba	IAG-MAS Member
MRV	Fritz	Stahr	IAG-MAS Member
Ocean Data	Andy	Ziegwied	IAG-MAS Member
Offshore Sensing AS	David	Peddie	IAG-MAS Member
PLOCAN	Carlos	Barrera	GROOM II partner
Pôle Mer Méditerranée	Charlène	Auregan	GROOM II partner
Pôle Mer Méditerranée	Chloé	Bourillon	GROOM II partner
RBR	Didier	Clech	IAG-MAS Member
SCOOT	Torsten	Linders	IAG-MAS Member
Stratmar Conseil	Patrick	Baraona	GROOM II partner
4H-Jena	Nadja	Kinski	IAG-MAS Member
Total : 23	12 consortium members		
	11 IAG-MAS members		

5.1.3 Meeting minutes of the second Industrial Advisory Group Maritime Autonomous Systems, October 4, 2022

Welcome and agenda

INTRODUCTION – 15 MIN

Objectives of the workshop:

- Building collaboration and trust
- Answering concerns from the previous workshop: what is the positioning of the RI? What is its role regarding industry - fostering cooperation or competition?
- Reach a priority list or consensus on most suitable Emerging Sectors and Innovations for MAS

In practice:

- Review the concept of the GROOM RI
- Ice Breaker
- Potential status of the future RI
- Services – Involvement of industrial members of GROOM RI
- Conclusion and next steps

Groom RI is about making ocean gliders and long-range autonomous systems widely accessible in large numbers to three categories of users:

- Research and academic users
- Observing systems and statutory monitoring
- Industry and beyond

GROOM RI VEHICLES

Ocean gliders, long range autonomous systems (gliders, surface vehicles, long range underwater vehicles) because they have unit characteristics (complex data sets, way of operating and managing those sets is different from a boat or a ship).

GROOM partners currently represent 36 glider ports where gliders and surface vehicles are operated and can be accessed by the users.

VISION STATEMENT OF FUTURE RI

To be the leading European Research Infrastructure in the provision of high-quality ocean observation data and services for the benefit of society, enabling scientific excellence through harnessing the advantages of Marine Autonomous Systems (MAS).

MISSION STATEMENT

This European RI integrates national infrastructures for MAS to provide access to platforms and services and expertise to the broadest range of scientific and industrial users.

It maintains a unique centralized provision of cyber-infrastructure, data, and knowledge for the optimized use of MAS to study climate and marine environments and to support operational services and the blue economy.

OBJECTIVES

As a formal entity, the RI will ensure **cooperation, coordination, integration, and simplification to provide access to world-class marine autonomous services.** The RI will:

- Connect scientists and industry with autonomous marine platform operators and integrators
- Support research, management, and blue economy (help create knowledge, technology, services)
- Ensure high value data production and good access to data which flows for societal benefits
- Guide technological development, best practices, frontier science and process studies

WHY HAVE A RI?

- Increased need and value for low carbon ocean observations
- Rapid rise of glider, long-range AUV and surface vehicle technology and near real time data availability
- New technological developments that enable effective and secure data sharing, data integration and data enrichment.

Added Value of the MAS Research Infrastructure:

- Reduce fragmentation of the research and innovation ecosystem
- Avoid duplication of effort
- Joint force to construct and run large, complex, or expensive infrastructures
- Invite industries to the co-developments of new technologies, methods
- Use scientific collaboration to address common problems and build partnerships
- Serving the blue economy by offering opportunities to industries to develop, test, and demonstrate their products
- Respond adequately and timely to global challenges.

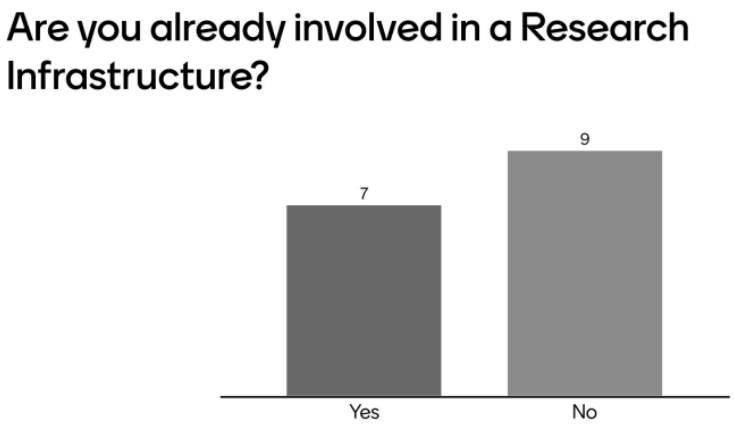
It aims to serve the blue economy by offering industries to develop, test, and demonstrate their products and respond adequately and timely to global challenges.

OBJECTIVES OF IAG MAS

- **Strengthen relationship** between industrial & national/EU scientific & technical stakeholders
- Develop a cooperative framework between researchers & MAS service providers for GROOM RI access
- **Identify & advance priorities for innovation** in developing new MAS and products & services
- Exchange views on the industry's needs & the available assets & expertise in GROOM
- Most importantly, produce a set of inter-related outcomes for the emerging research infrastructures.

Ice breaker (Mentimeter)

Are you already involved in a Research Infrastructure?



7 industrials are already involved in a Research Infrastructure such as OTC (Ocean Thematic Centre) of the ICOS community, Ferry Box Community, EMSO, Euro Fleets and Argo.

Potential legal status of the future RI

Legal status of the GROOM RI

GROOM II project focuses on structuring and developing MAS operations in Europe, and it designs the future European Research Infrastructure (GROOM RI). Some legal statuses are considerate:

- MoU's
- Association (AISBL-type)
- Join an existing RI or merge with another project
- ESFRI (European Strategy Forum on Research Infrastructure) roadmap and ERIC (European Research Infrastructure Consortium), status recognised by the European Union.

Webinar

GROOM II organised two webinars on Marine European Research Infrastructures. The **first one** is dedicated to understanding the different steps required to build an official and sustainable RI – what is at stake and what it implies. In this regard, knowledge exchange with other RIs is crucial, leading to better preparedness and avoidance of common pitfalls, duplication of work and competition. **It was hold on Thursday 13th October 2022.**

The **second webinar** will be organised with the representatives of ERICs (EMSO, Euro-Argo, EMBRC) and another 'mature' AISBL (SeaDataNet, EuroGOOS) with the main question on how the legal status of the RIs affects the different services and the financial functioning of the RIs (exchanges of services between partners, etc). This webinar will be held in November 2022.

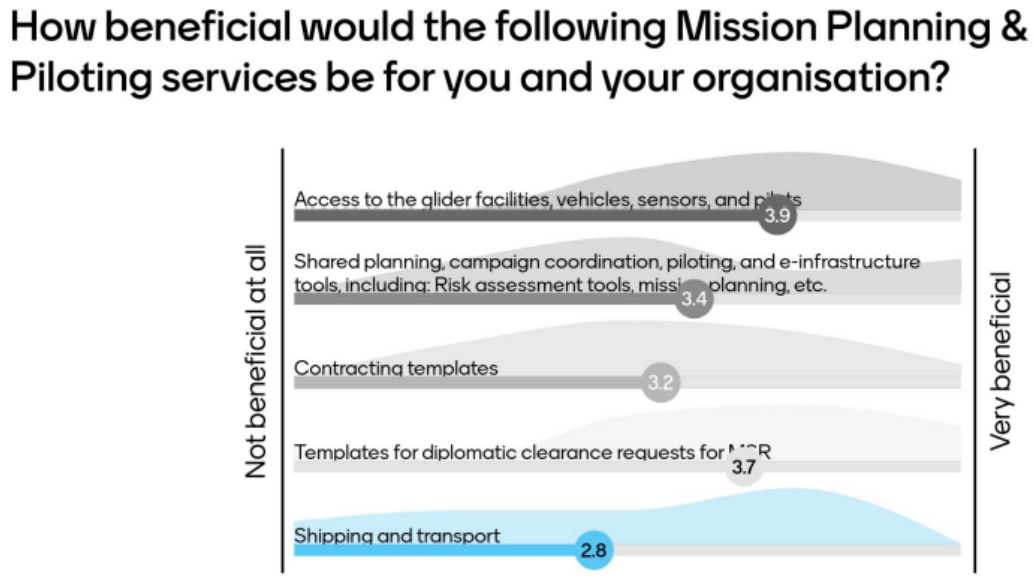
- *Do you see any restrictions regarding the legal status of the future RI?*

"The important is to know how the company will interact with the RI and how we will be involved".

The function of the RI is more important than its legal status.

Services – Involvement of industrial members of GROOM RI

Mission planning & piloting

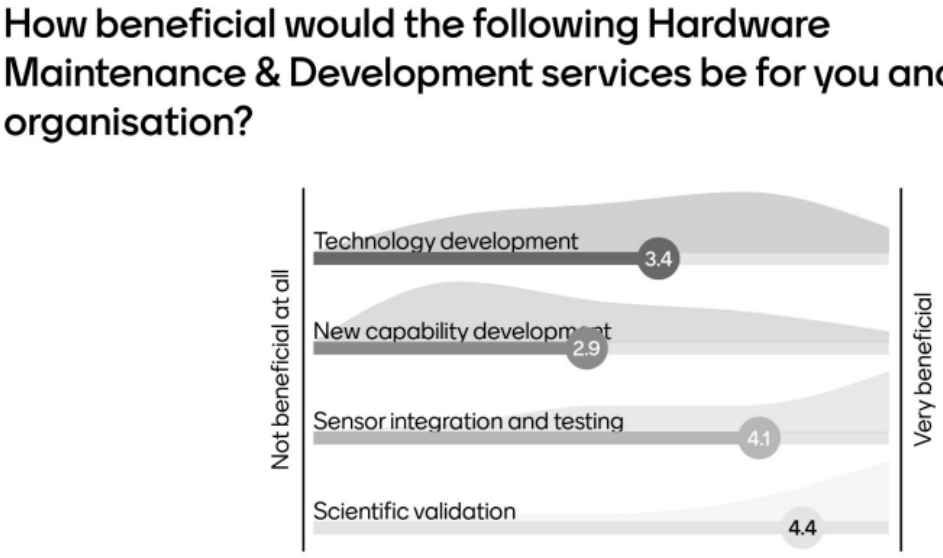


According to the participants, *access to the glider facilities, vehicles, sensors, and pilots* is the most beneficial services relating to mission planning and piloting. "Shared planning campaign coordination, piloting and e-infrastructure tools (including risk assessment tools and missions planning)" is the second most important service.

- *There will be a physical point for the RI?*

"It will be a distributed infrastructure so it will be held by a head quarter relaying the services provided by the contact points in different countries. Some of them are already existing."

Hardware maintenance & development

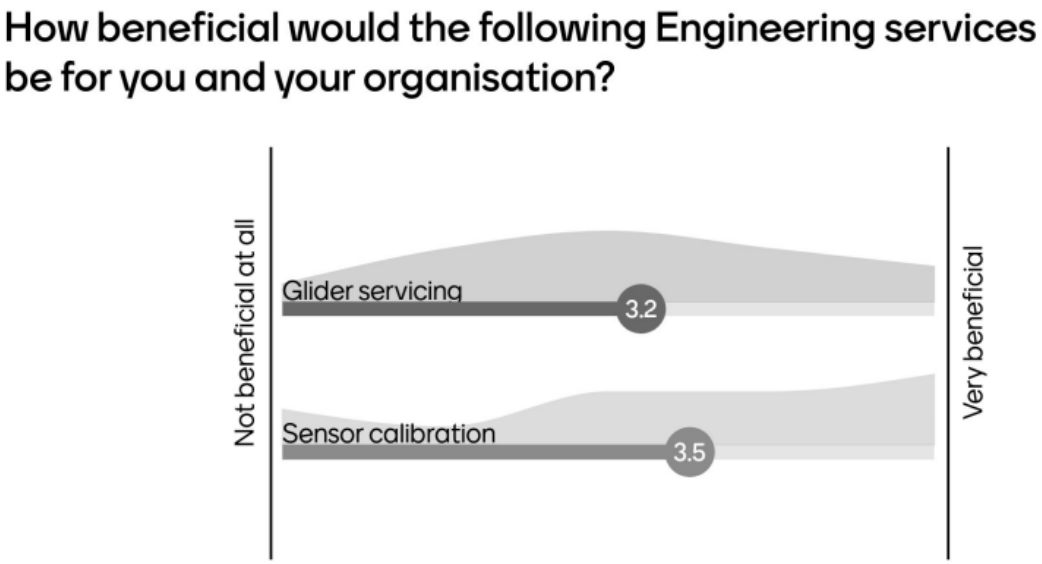


According to the participants, *scientific validation* and *sensor integration and testing* are the hardware maintenance and development services that will be the most beneficial for them. GROOM II project will build one unique roadmap to satisfy all the contact points which will be involved but also the industrials.

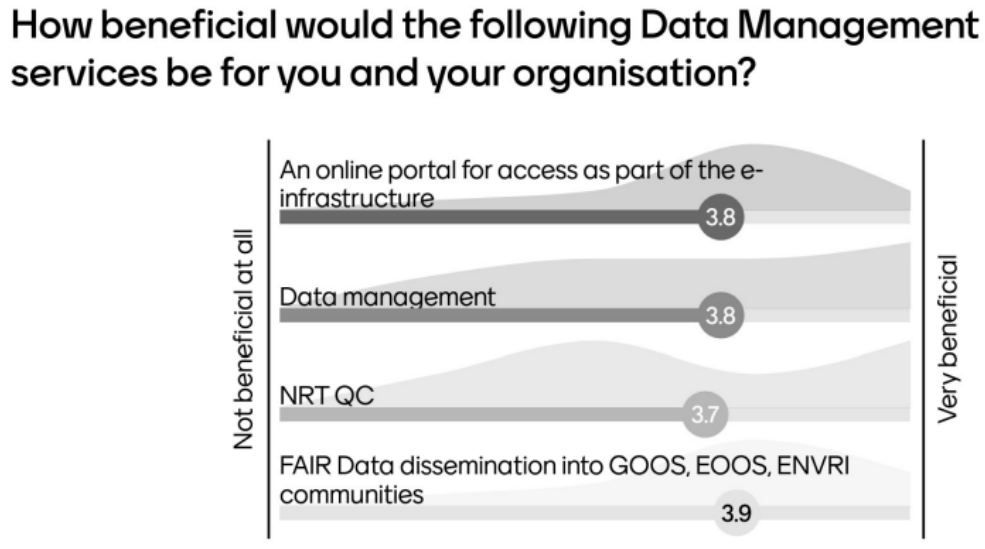
"You should show and prove the RI will create a real community, then you could address services that will be truly beneficial to the community. "

Engineering services

Sensor calibration seems to be the engineering services that will be the most beneficial for industrials. However, the gap between glider servicing and sensor calibration is minimal and both services should be considered in the future RI.



Data management

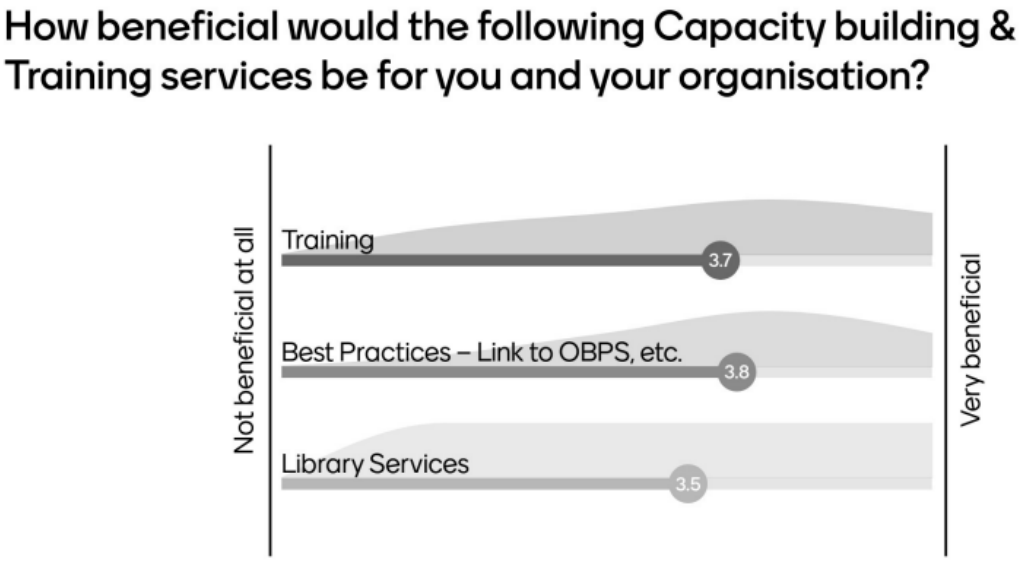


According to the IAG MAS members, these data management services should be considered because they are important for their companies, and they bring benefits:

- FAIR Data dissemination into G b OOS, EOOS, ENVRI communities
- An online portal for access as part of the e-infrastructure
- Data management
- NRT QC.

"*If you want to offer services, you should simplify a lot. If I want a service from a RI, I want to know if it works efficiently and seamlessly […]".*

Capacity building & training



Regarding capacity building and training services, the best practices (link to OBPS, …) are the most beneficial for industries following by training and library services.

- *Do you have any suggestions for other services the RI could provide?*

"You should think about the coordination deployments between platform (gliders, surface vessels, …) services."

Conclusion and next steps

Questionnaire

As GROOM RI will have a facilitator role where industrials will be a key component, we need your help to define more precisely the RI. Please, give us your opinion by 31st October 2022 by filling in this online survey (5-10minutes): https://ec.europa.eu/eusurvey/runner/survey-groom-ri-2022#page0

Participants

Organisation	Name	Surname	Category
ARMINES	Laurent	Mortier	GROOM II partner
ARMINES	Kamil	Szafranski	GROOM II partner
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KM Kongsberg	Peer	Fietzek	IAG MAS Member
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Marine Institute	Sebastiaan	Swart	GROOM II partner
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Offshore Sensing AS	David	Peddie	IAG-MAS Member
PLOCAN	Carlos	Barrera	GROOM II partner
PLOCAN	Andres	Cianca	GROOM II partner
Pôle Mer Méditerranée	Charlène	Auregan	GROOM II partner
Pôle Mer Méditerranée	Chloé	Bourillon	GROOM II partner
Pôle Mer Méditerranée	Magali	Gebelin	GROOM II partner
Pytheas Technology	Rémi	Pascual	IAG-MAS Member
SCOOT	Torsten	Linders	IAG-MAS Member
Sea Bird	Jochen	Klinke	IAG MAS Member
SonarDyne	Aidan	Thorn	IAG MAS Member
Stratmar Conseil	Patrick	Baraona	GROOM II partner
UGOT	Bastien	Queste	GROOM II partner
4H-Jena	Nadja	Kinski	IAG-MAS Member
	François	Leroy	IAG MAS Member
Total: 24	14 consortium members		
	10 IAG-MAS members		

5.2 SURVEY

5.2.1 Expectations from industrial members regarding the future GROOM RI

INTRODUCTION

GROOM RI aims to be the European Research Infrastructure (RI) harnessing the advantages of Marine Autonomous Systems (MAS). GROOM RI provides high-quality ocean observation data and services for the benefit of society both enabling scientific excellence and moving towards net-zero activities. This European RI integrates national infrastructures for Marine Autonomous Systems (MAS) to provide access to platforms and services to the broadest range of scientific and industrial users, as well as other ocean observing RIs. It maintains a unique centralised provision of cyber-infrastructure, data and knowledge for the optimised use of MAS to study climate and marine environments as well as support operational services and the blue economy.

GROOM RI will play a key role as a facilitator that matches industrial members' needs, promotes their products & services and develops healthy collaboration. The GROOM II project intends to create an advanced design of this research infrastructure. By collecting information about your industrial needs and activities, your collaboration will guide our decisions about the legal, technical and scientific structure of the RI so it fits your needs.

The consortium is composed of 14 partners in 12 countries including France, Germany, Cyprus, Norway, United-Kingdom, Ireland, Greece, Spain, Portugal, Finland, Sweden and the Netherlands. All information related to partnerships are available here.

The results of this survey will help us reach our objective to optimally design the RI. By collecting information about your industrial needs and activities, your collaboration will guide our decisions about the composition of the RI so it fits your needs.

By filling out this form you agree that we will process your data for the purposes of the GROOM II Project. All the collected information will be confidential. You can answer this survey by 31st October 2022.

1. **EXPECTATIONS AND NEEDS**

GROOM RI aims to provide efficient services. The answers to the following questions will guide our understanding about your expectations and needs in regard to the RI.

Q1.1 Indicate the service(s) that you are interested in and/or positioning your organisation on:

- Mission planning and piloting (access to glider facilities, vehicles, sensors; shared planning, campaign coordination, piloting, …)
- Hardware maintenance and development (new capability development, sensor integration and testing, scientific validation)
- Engineering services (glider servicing, sensor collaboration)
- Data management (online portal for access as part of the e-infrastructure, NRT QC, FAIR data dissemination into GOOS, EOOS, ENVRI communities)
- Capacity building and training (training, best practices - link to OBPS, etc., library services)
- Other (please specify)

Q1.2 What could GROOM RI bring to your organisation?

- Competitive intelligence
- Finding new prospects & clients
- International awareness
- Participation in scientific studies
- Scientific competitiveness
- Showcasing your products and/or services
- Other (please specify)

Q1.3 How may GROOM RI promote your company?

- Catalogue
- Online visibility: social media & website
- Conferences
- Dissemination to scientific experts and researchers and industrial actors
- Other (please specify)

Q1.4. What are your expectations when cooperating with other members & stakeholders of the RI?

- Develop high quality services (joint development)
- Develop your network (customers, partners, experts)
- Share costs (missions, projects, communication, …)
- Share resources
- Other (please, specify)

Q1.5. Since the GROOM RI acts as a facilitator, which measures should be considered to guarantee a healthy collaboration?

- Access to software and/or hardware
- Specific agreement of cooperation, including non-competition in some situations
- Validation of disseminated information (news, promotion of your activities, …)
- Other (please specify)

2. MARKETS AND POSITIONING

GROOM RI will be tailored to your needs. The answers to the following questions will guide our understanding of which markets you address, what type of services you offer, and which emergent markets you may be interested in in the future.

Q2.1. In which market(s) are you currently positioned?

- Data management
- Data provider

- Defence & marine surveillance
- Marine environment observation
- Marine renewable energy including its environmental impact on marine & coastal ecosystem
- Offshore & deep offshore non-renewable energy & minerals
- Sensor(s) developer & provider (chemical, nutrients, etc.)
- Survey & maintenance of marine infrastructures (including ports, artificial reefs, telecommunication cables…)
- Other (please specify)

Q2.2. Of these emerging sectors, what are the 3 technological priorities for your industry?

- Advanced automatic missions for new capabilities
- eDNA (invasive species, biodiversity)
- Methane & CO2 (GHG monitoring, budget estimates)
- Nutrient sensors
- Real time echosounders (fish, larvae, other plankton)
- Real time passive acoustic monitoring (PAM) (targets, wind, rain, marine traffic)
- Water sampling (pollution, water quality)
- Other (please specify)

Q2.3. What are the technologies/products or services that you could make available to GROOM RI?

Products / Services/ Technologies	Yes	No	I don't know yet
Acoustic sensors (measurement, detection, identification..)			
Autonomous Underwater Vehicle			
Positioning system			
Radio Communication & satellite communication			
Remotely Operated Vehicle (ROV)			
Surface uncrewed vehicle			
Underwater glider			
AUV (including gliders)			
Data report			
Surface drone services			
Training			

Buoyancy			
Data collection			
Embedded energy			
Mine clearance			
On-board intelligent command control			
Provide decision support			
Underwater communication (acoustic, optical …)			

3. INDUSTRIALS INVOLVEMENT IN THE RI

This part aims to understand what your preferences regarding administrative aspects are and to evaluate your level of interest for this kind of infrastructure. No commitment is implied.

Q3.1. Would you be interested in being part of GROOM RI?

Yes, possibly → Q2

No, please specify the reason → end of the survey

Q3.2. Would you like to play an active role in GROOM RI governance?

- Yes, a consultative role
- Yes, a decision-making role
- I don't know yet → Q4
- No → Q4

Q3.3. What are your main motivations to participate in GROOM RI?

- For cooperation with other companies
- For cooperation with scientists
- To access information about products, markets, …
- To access a network of professionals & scientists
- To add capabilities without significant new investments
- Other (please specify)

Q3.4. Would you consider making hardware, software or human resources available to the RI? (in kind)

- Yes, hardware
- Yes, software

- Yes, human resources
- I don't know yet
- No

Q3.5. Would you consider paying a membership fee to be part of the RI?

- Yes
- No
- Conditionally, yes, (please clarify)

Q3.6. Are you currently involved in another research infrastructure?

- Yes → Q7
- No

Q3.7. Specify the name of the research infrastructure, its objectives, and your role in this RI:

_____

GENERAL INFORMATION ABOUT THE RESPONDENT

- Name
- Surname
- E-mail
- Organisation
- Position

THANK YOU NOTE

Thank you for taking the time to answer this survey. Your contribution will truly help us provide you with an innovative research infrastructure adapted to your needs.

Do you have any questions or suggestions regarding this future RI?

5.2.2 Results of the questionnaire

GROOM II_Questionnaire_Analy