

# Work programme for the MAROFF programme Revised 2017

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Maritime Activities and Offshore Operations – MAROFF

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# Summary

The Innovation Programme for Maritime Activities and Offshore Operations (MAROFF) will provide support for research and development activities that help to increase value creation in the maritime industry. The MAROFF programme's target groups are shipping companies, the shipbuilding industry, service providers and equipment suppliers to all types of vessels for utilising ocean space, including vessels and maritime technology for other ocean industries (including aquaculture, fisheries, offshore oil and gas, and offshore renewable energy). The target groups also include research groups in technology and social science-related fields of importance to the maritime sector in Norway.

The programme seeks to work within a sustainable framework to enhance competitiveness, strengthen the capacity for restructuring and improve interactivity and knowledge transfer between the R&D community and the industry.

Research activities will help to create new competencies and innovations in the thematic priority areas under the programme:

- Opportunities in ocean industries;
- Autonomous and remote-controlled vessels;
- Digital transformation of the maritime industry;
- Promoting greener maritime activities;
- Safety and security at sea;
- The Arctic and northern areas.

**Innovation Projects for the Industrial Sector** are the programme's most important funding instrument for promoting value creation in the maritime industry. **Knowledge-building Projects for Industry** will be used to improve interactivity and knowledge transfer between the R&D community and the industry and to help to train new researchers. **These are the two key application types employed by the programme.** Other application types or activities may be called for to address specific challenges or topics.

## 1 Background

Norway's maritime industry encompasses shipping companies, shipyards and suppliers of maritime services and equipment. The industry is at the international forefront, with competitive companies across the entire spectrum of maritime industrial activities and operations worldwide. The industry has a very high share of exports, and revenues from the export of goods and services account for a significant proportion of its value creation. The industry is adept at restructuring, which is why Norway is one of a few high-cost countries that still builds ships. The industry is of major importance to local and regional value creation and employment. When petroleum activities started in Norway, shipyards turned to the production of platforms, offshore vessels and subsea technology, which provided new opportunities for the maritime industry.

A significant boost in investment in research, development and innovation (RD&I) for the maritime industry is essential if Norway is to maintain its status as a leading maritime nation. Expanding maritime innovation through collaboration, knowledge transfer and technology exchange will create new opportunities for exploiting the potential of the emerging ocean industries. Fully exploiting the synergies between these industries will require a unified strategic effort. The MAROFF programme

will work to ensure that maritime expertise and technology are applied across Norway's various ocean industries.

Industrial activities utilising ocean space will create wide-ranging ripple effects for the maritime industry through increased demand for maritime products and services along the entire value chain. The development of new products and services that can be used to exploit the potential of ocean space will be critical to the further expansion of the industry.

### *Relevant strategies and guidelines*

The Norwegian Government's 2017 Ocean Strategy, *New Growth, Proud History*, stresses the importance of improving the transfer of knowledge and technology between the ocean industries and states that "maritime knowledge is vital to the development of the seafood industry, changes in the petroleum sector, and the development and utilisation of technology in the ocean." The 2014 *Long-term plan for research and higher education 2015–2024* identifies the seas and oceans as one of six priority areas. The 2017 white paper on industrial policy, *A Greener, Smarter and More Innovative Industry*, identifies the maritime industry as one of Norway's three important ocean industries.

The MAROFF programme is the Research Council of Norway's main instrument for research targeted towards the maritime and offshore industries and their research partners. The programme works to realise the objectives of the Norwegian Government's 2015 Maritime Strategy, *Maritime Opportunities – Blue Growth for a Green Future*. The programme also helps to implement the recommendations of *Maritim21: An integrated maritime strategy for research, development and innovation* (2016).

The MAROFF programme works to achieve the greatest possible overall value creation in the Norwegian economy within a sustainable framework, which is the overall objective set out by the Ministry of Trade, Industry and Fisheries in its allocation letter to the Research Council. Increasing value creation will entail:

- enhancing competitiveness in new and existing industries;
- strengthening restructuring capacity in the Norwegian economy;
- improving interactivity and knowledge transfer between the R&D community and trade and industry.

Furthermore, the programme will follow up the *Strategy for the Research Council of Norway for an innovative business sector 2016–2020*. Several of the measures proposed in the strategy are aligned with the Maritim21 recommendations and promote the achievement of the Ministry of Trade, Industry and Fisheries' objective.

## **2 Challenges**

The Maritim21 strategy identifies several challenges facing the maritime industry: changes in the market situation, the need for efficiency measures in the industry, rapidly changing technology and business models, climate change, new safety and security challenges, and increased activity in the Arctic and northern areas.

These challenges also represent opportunities for industrial development through exploration of new markets, realisation of the potential of new technology and business models, and design of solutions to help to achieve climate targets.

### *Changes in the market situation*

Seventy per cent of the maritime industry is oriented towards the petroleum industry. The decline in oil and gas activities has put large segments of the maritime industry under pressure, with the offshore fleet laid up, fewer orders on the books and reduced activity levels among equipment manufacturers. The industry needs to seek out new markets and opportunities.

### *Need for efficiency measures*

Innovation is increasingly fast-paced in the current economic climate. As a high-cost country Norway must therefore distinguish itself in other areas. Norway must utilise new technology to increase efficiency, cut costs and boost productivity. It is essential to find cheaper solutions, employ smart design, expand recycling, etc.

### *Rapidly changing technology*

Rapid, wide-ranging technological changes are creating challenges in and of themselves. The digital transformation of society and the maritime industry is well underway, bringing changes in production, business models and customer interaction. Companies and research groups need to have the expertise and experience to exploit emerging technologies. Smaller companies in particular may find it difficult to stay up-to-date. Widespread digitalisation and remote control are accompanied by new types of risk and a need for more stringent cybersecurity and more secure communications.

### *Climate change*

In future, the maritime and offshore industries must reduce greenhouse gas emissions, minimise harmful discharges to water and increase energy efficiency. The Paris Agreement adopted at the 2015 United Nations Climate Change Conference (COP 21) has led to expectations for stricter requirements for emissions reduction and a strong commitment to reducing the environmental and climate impacts of the transport sector. Alternative energy sources such as liquefied natural gas (LNG), batteries and hydrogen as well as hybrid solutions for ship propulsion comprise an important area of focus. Green shipping will make an important contribution to reducing Norway's greenhouse gas emissions. The Norwegian maritime industry must make the transition to zero- and low-emission solutions in order to remain competitive.

### *New safety and security challenges*

New energy carriers entail new and changed risks that must be understood before such energy carriers can be implemented. Climate change also poses challenges for safety and security at sea, and there is a need for better understanding of the impact of changing climatic conditions on the maritime industry, operational patterns and operating conditions. New technologies and new, more complex systems will create new challenges for those who will be designing and using these systems.

### *Increased activity in the Arctic and northern areas*

Maritime activity in the Arctic and northern areas is on the rise in connection with tourism, fisheries, exploration and recovery of oil and gas, and sea transport. Norwegian maritime actors are engaged in commercial activities in these areas, and the most highly trafficked waters are located within Norway's jurisdiction. Transport and operations in the Arctic are demanding due to long distances and harsh conditions such as cold, darkness, ice and icing.

## 3 Objectives for the programme

### 3.1 Primary objective and target groups

The MAROFF programme will provide support for research and development activities that help to increase value creation in the maritime industry within a sustainable framework by enhancing competitiveness, strengthening the capacity for restructuring and improving interactivity and knowledge transfer between the R&D community and the industry.

The MAROFF programme's target groups are shipping companies, the shipbuilding industry, service providers and equipment suppliers to all types of vessels for utilising ocean space, including vessels and maritime technology for other ocean industries (including aquaculture, fisheries, offshore oil and gas, and offshore renewable energy). The target groups also include research groups in technology and social science-related fields of importance to the maritime sector in Norway.

### 3.2 Secondary objectives

Research activities under the programme will help to create new competencies and innovations in the following thematic priority areas:

- Opportunities in ocean industries;
- Autonomous and remote-controlled vessels;
- Digital transformation of the maritime industry;
- Promoting greener maritime activities;
- Safety and security at sea;
- The Arctic and northern areas.

## 4 Thematic and scientific priority areas

### *Scientific scope*

Both together and separately the thematic priority areas encompass a wide range of technology and scientific areas. Norway must develop its competency in the areas that are crucial for further developing the maritime industry and safeguarding Norwegian competitiveness. There is a need for expertise in traditional maritime topics such as vessel design, hydrodynamics, marine construction and production, machinery and propulsion systems, marine cybernetics and steering systems, system engineering, and maritime economics and logistics. Greater competency in enabling technologies such as automation, decision support and interaction, communications and navigation, and new materials and production methods is also critical.

### *Sustainability perspectives*

Norway's ocean industries must be developed within a sustainable framework to safeguard the climate and environment as well as to ensure safety and security at sea, global competitiveness and stable value creation that is less dependent on the prices of raw materials.

### *Relationship to EU framework programmes*

Transport is one of the Societal Challenges under the EU Framework Programme for Research and Innovation, Horizon 2020. The amount of EU funding awarded to maritime research is relatively modest. Maritime research is important for Norway, and must to a large extent be nationally funded.

The MAROFF programme will help Norwegian applicants to qualify for funding under EU calls for proposals that overlap the programme's sphere of responsibility.

The most relevant H2020 calls are "Blue Growth" and "Mobility for Growth". Collaboration on calls under the Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans) may also be of relevance.

The MAROFF programme's thematic priority areas are described below. These areas reflect challenges facing the maritime industry and are based on the recommendations in the Maritim21 strategy.

## **4.1 Opportunities in ocean industries**

The Norwegian ocean industries encompass maritime activities (sea transport and maritime operations), seafood production (fisheries and aquaculture) and offshore energy (offshore oil and gas recovery and offshore wind power). Over the years Norway has developed world-leading technology within these sectors which together form the country's strongest industrial cluster. Maritime knowledge is vital to the further development of the ocean industries and for the development and application of ocean technology. To offset the challenges of the decline in maritime activities related to offshore oil and gas activities, the industry must innovate and find new markets and opportunities in existing markets. It is important to turn an eye towards growing markets and/or markets where Norway has competitive advantages. As a small nation, Norway must build on existing industry if it is to achieve success in ocean space in the near future. Within the framework of the emerging global ocean industries, Norway has much to gain from exploiting the synergies between its various ocean industries.

The growing global population, greater prosperity, increasing pressure on natural resources, climate challenges and new technologies are driving the creation of new ocean industries. These new industries include offshore wind power production, oil and gas recovery in ultra-deep waters and in particularly harsh conditions, offshore aquaculture, seabed mining, ocean tourism, fishing of lower trophic level species, fishing in deeper waters and marine biotechnology. There is significant potential for innovation, new jobs and economic growth in these areas in the long term. Collaboration across industries and sectors and between the research and industrial communities will be essential.

The supply of maritime services is an important segment of the Norwegian maritime industry. New technologies and markets may lead to new services and business models. New business models and services often require new organisational solutions, which in turn may again lead to new services. All this will have an impact on decision-making and service supply within the maritime industry.

## **4.2 Autonomous and remote-controlled vessels**

Autonomy, automation and remote control are very promising in terms of cutting costs and enhancing the safety of operations, and may make sea transport competitive in new market segments. Solutions for automated vessel and cargo management may reduce costs significantly, improve customer service and facilitate higher transport frequency at lower costs. The use of automated and autonomous vessels will also help to shift more cargo transport from the road to the sea. However, the introduction of autonomous vessels will have consequences for safety, legal and ethical norms, among others. The regulatory framework will have to be adapted and the requirements for cybersecurity made more stringent in the areas of navigation, communications,



monitoring and redundancy. Remote-controlled, automated and autonomous vessels will also open up major opportunities and call for new business models.

The development of autonomous vessels will require collaboration across disciplines (technology and social science), between various actors (companies, research groups and the public authorities) and between different transport modes (sea transport and land transport).

### **4.3 Digital transformation of the maritime industry**

Norway is a high-cost country with productivity-related challenges so boosting efficiency in the maritime industry is vital. Increased automation and robotisation will facilitate this. Digitalisation will be important throughout the entire maritime value chain, from design and production to technical and commercial operations.

#### **Design and production**

Design and production of ships and equipment must be cost-effective. In addition, ships and equipment must be designed to operate in the most cost-effective, environment-friendly and safe manner possible. Simulation, virtual prototyping and virtual testing will enable the testing of complete systems early in the design phase. Automation and robotisation will improve the efficiency of the production phase.

Digital interfaces must be developed and standardised, components and equipment must be developed and tested, and data must be stored and shared. Digitalisation will facilitate innovation in products and processes that will enhance companies' productivity.

#### **Operations**

Vessel operations must be as cost-effective, safe and environment-friendly as possible. To ensure optimal operations, data from the digital value chain can be used to simulate and plan complex operations as well as to train personnel with the help of simulators. Data from actual operations can be compiled and later used for improving simulation models.

Each ship will have its own digital infrastructure. Sensors will measure data from various systems, networks will collect this data, and advanced interaction technology supported by analysis and simulation models will provide the operator with decision support. Creating this digital infrastructure will require developing necessary technology and components along with the digital interface to tie these together.

Advanced commercial and operative decision support systems for operations can yield a higher degree of efficiency, utilisation, reliability and safety. Predictive systems for decision support and data analysis will be drivers for optimising and safeguarding technical and commercial operations through more effective prevention and management of undesirable events.

#### **Logistics**

Providing reliable transport and logistics is dependent on a comprehensive transport chain with good transport solutions and hubs. Effective cargo handling will enhance the competitiveness of Norwegian actors and sea transport in general. There is a general need to generate greater awareness about sea transport as well as deeper understanding of the obstacles involved in, and effective incentives and measures for, shifting more transport from the road to the sea.

If maritime transport is to cover more of the increase in transport volume, more solutions for cost-effective transport and logistics operations need to be developed. Optimisation of routes, fleet

operations and supply chains can greatly enhance efficiency. There is also a need for decision support systems for planning and operations.

#### **Marine data and data from marine operations**

Effective exploitation of ocean space requires technologies for monitoring, data collection and communications. Marine data and operational data from ships and equipment must be used to optimise design and operations. Expertise and technology are needed to analyse the large amounts of data generated. There may be fresh opportunities for Norwegian maritime companies in this area.

## **4.4 Promoting greener maritime activities**

Given the current level of emissions and projections for the future, dramatic measures are called for to reduce energy needs and increase energy efficiency as well as to develop new energy carriers and cleaning technology. There is great potential for value creation in technologies and methods for reducing emissions to air and water. The reduction in emissions called for by commercial actors, the public authorities and society at large will drive the need for effective, scalable solutions.

#### **Reducing energy needs and increasing energy efficiency**

Reducing the energy needed to carry out a given operation as well as increasing the degree of utilisation of the energy will cut associated energy costs. Good detailed measurements will be an important step in the right direction. In order to reduce energy needs it is important to look at optimising vessel design and operation. There is a need to increase energy efficiency in every component of a vessel, from tanks to propellers.

#### **Alternative fuels/energy carriers**

The most readily available alternatives to traditional oil-based fuels are liquefied natural gas (LNG), electricity, biofuels, liquefied petroleum gas (LPG) and hydrogen. These can reduce emissions of greenhouse gases and other environmentally and health hazardous substances to varying degrees. Norway is at the forefront when it comes to the use of batteries for ship propulsion, either in the form of fully electric or hybrid solutions, and there is still a need to develop and operationalise electric solutions. Norway is also a leader in the use of LNG as fuel for ships. Effort must be invested in making LNG and LPG competitive alternatives for vessels travelling longer routes.

#### **Cleaning and reducing emissions to air and water**

The market potential for cleaning of emissions is affected by regulatory measures, so research and development in this area must be closely linked to the regulatory regime. In relation to existing regulations, the greatest market potential and knowledge needs relate to for SO<sub>x</sub> scrubbers, NO<sub>x</sub> catalysts and ballast water treatment. New targets for reduction in CO<sub>2</sub> emissions may also create a need for new solutions.

#### **Framework conditions and market mechanisms**

More knowledge is needed about incentives in the form of quotas, fees and deductions. Effective solutions for quantifying consumption and emissions can provide a basis for future fee regimes. There is also a need for more knowledge on how contracts and tendering and licensing terms and conditions can be designed to encourage more environment-friendly solutions.

## 4.5 Safety and security at sea

Safety and security at sea involves ensuring the safety of humans, values and the environment as well as security and protection against external attack. Safety and security can be improved both through preventive measures to reduce the probability of an undesirable event and through mitigation and preparedness measures to limit the impact of an undesirable incident should it occur.

Widespread digitalisation, new energy carriers and climate change are giving rise to new safety and security challenges, and a deeper understanding and new solutions will be required to deal with these. Operator error, interaction failure, and a lack of competence and organisational learning are pressing problems in the context of operational safety. New technology and increased autonomy will place new demands on the personnel operating and monitoring the systems. Technology development must take place in parallel with the development of skills and interaction among personnel.

## 4.6 The Arctic and northern areas

Operations in parts of the Arctic region are highly demanding, and call for the development of technology and operational systems adapted to the Arctic climate. Tailored systems for enhancing safety, monitoring, emergency preparedness, search and rescue, and towing and salvage as well as personal and collective rescue equipment must be developed. Given the long distances to be traversed, logistics solutions that optimally utilise infrastructure and services for land, air and sea transport in the region must also be developed.

# 5 Priorities for structuring the research effort

The MAROFF programme will provide support for research and development activities that help to increase value creation in the maritime industry within a sustainable framework by enhancing competitiveness, strengthening the capacity for restructuring and improving interactivity and knowledge transfer between the R&D community and the industry.

### *Types of support*

**Innovation Projects for the Industrial Sector** are the programme's most important funding instrument for promoting value creation in the maritime industry. **Knowledge-building Projects for Industry** will be used to improve interactivity and knowledge transfer between the R&D community and the industry and to help to educate new researchers. **These are the two key application types employed by the programme.** Other application types or activities may be called for to address certain challenges.

The maritime industry is undergoing change and faces major, complex challenges. Dealing with these will require a unified approach, long-term efforts, collaboration across disciplines and sectors and the participation of all the various stakeholders. There may be a need here for **targeted large-scale projects**. The MAROFF programme is open to providing support for this type of project, particularly in emerging areas that will promote competitiveness and strengthen restructuring capacity. Finding solutions to major challenges may require access to new **RD&I infrastructure** to facilitate and accelerate the pace of maritime research. Support for infrastructure is provided under dedicated schemes at the Research Council.

There may be a need to explore how new areas can be developed optimally. If necessary, the programme may prepare **knowledge bases** in these areas. It may also be of relevance to build fundamental expertise and new knowledge using **Researcher Projects** in areas that are not covered by other programmes.

The industry is undergoing rapid technological change, which calls for a higher pace of innovation. Companies must be equipped to exploit new market opportunities quickly and bring their products to the market faster. There may be a need for verification of new solutions before they can be implemented. **Demonstration projects** are an important instrument in this context. Such projects may entail full-scale testing of experimental technology for ships/facilities that is no longer suitable for lab-scale testing. Support is currently provided for this type of testing within the framework of innovation projects, but it may be beneficial to establish a dedicated scheme for this purpose. Support for the use of infrastructure in demonstration and verification activities is provided under other schemes such as the *Norsk katapult* [Norwegian catapult] support scheme.

Exploiting new markets or new technologies may require research projects with a high level of risk and an interdisciplinary approach. The MAROFF programme has previously participated in a call for proposals under the Research Council's **Idélab** initiative, with the objective of cultivating new, breakthrough research. Participation in future Idélab calls for proposals may be of interest.

#### *User participation*

User participation in research projects is essential for ensuring that the projects are of relevance and benefit to trade and industry. The MAROFF programme will take active steps to ensure that the **maritime industry is represented** in all types of projects, either as project participants and/or through involvement in project management.

#### *Gender balance*

The maritime sector has traditionally been male-dominated. Although the proportion of women project managers has increased in recent years, **measures to further increase the proportion of women** will still be needed.

#### *Internationalisation*

Europe is an important arena for international RD&I cooperation. The EU Horizon 2020 framework programme encompasses topics and research areas of significance for actors in the Norwegian maritime cluster. By participating in EU-funded projects, Norwegian actors will not only tap into a crucial funding source, but also gain access to useful research results and establish contacts in Europe. The MAROFF programme administration will take part in **activities to increase participation** in Horizon 2020 and will provide **information and advice** to companies and research groups seeking to participate in H2020 calls for proposals.

With regard to international cooperation outside Horizon 2020, the MAROFF programme may among other things issue **joint bilateral calls for proposals**, possibly in collaboration with other programmes. The programme may also facilitate contact between Norwegian companies and research groups and leading international research groups.

#### *Social dialogue and networking*

The further expansion of the maritime industry is dependent on effective cooperation between all of the stakeholders. Mechanisms to promote cooperation within research and industrial communities, between research and industrial communities, and between experience-based knowledge, research and academia, are essential. Cooperation with the public authorities is also important.

It is possible to seek financial support from the programme for organising **networking events** where stakeholders can meet to discuss new challenges and research tasks. Support for such events will be contingent on the involvement of companies that have not previously sought funding for innovation projects from the Research Council. It will also be important to bring together actors from multiple ocean industries.

To encourage the dissemination of results from research projects, the programme offers financial support for **events for dissemination of research results**. The objective of the event must be to reach as many representatives of the relevant target groups as possible and the event must be open to all actors in the maritime sector. In addition to serving as a venue for presenting results from R&D projects, the event should be used to promote dialogue between the participants on how these results can be applied.

## 6 Cooperation with related instruments

Cooperation and coordination between the individual instruments will be critical in the years ahead, as the need for RD&I on interdisciplinary and cross-sectoral research questions will grow and knowledge will increasingly be utilised across industries. The MAROFF programme acknowledges the importance of further developing cooperation with other Research Council programmes, as well as with the regional research funds, Siva, Enova and Innovation Norway.

### *Cooperation with thematic programmes*

A number of thematic programmes at the Research Council share an interface with the MAROFF programme, and cooperation with several of these will be of interest. Relevant collaborative measures include joint calls for proposals for **Innovation Projects for the Industrial Sector** and possibly calls for proposals under the **Idélab** initiative.

Exploiting the opportunities in ocean industries will require cooperation with other programmes targeted towards these industries. This particularly applies to the programmes on aquaculture (Large-scale Programme for Aquaculture Research (HAVBRUK2)), offshore oil and gas (Large-scale Programme for Petroleum Research (PETROMAKS 2)), fisheries (Programme on Marine Resources and the Environment (MARINFORSK)), and offshore renewable energy (Large-scale Programme for Energy Research (ENERGIX)). The role of the MAROFF programme in such cooperation will be to support the development of vessels and maritime technology and equipment by its target groups.

ICT is essential to the development of autonomous vessels, so cooperation with the Research Council's Initiative for ICT and digital innovation (IKTPLUSS) may be useful. Cooperation with the Research Council's Transport 2025 programme, which views the transport system as an integrated whole, may also be of interest, especially when studying the transition between different transport modes in ports.

The digital transformation of the maritime industry will require cooperation across many disciplines in which expertise in enabling technologies is particularly important. Basic research on these technologies is carried out under the IKTPLUSS initiative, the Research Programme on Nanotechnology and Advanced Materials (NANO2021), and the Programme on Biotechnology for Innovation (BIOTEK2021). In the area of digitalisation of production, the MAROFF programme may cooperate with the Programme for User-driven Research-based Innovation (BIA), which has responsibility for production technology. In the area of digitalisation of logistics, it may be relevant to cooperate with the Transport 2025 programme, which covers the entire transport chain.

There are various programmes and funding instruments under the Research Council, Innovation Norway and Enova that support the development of climate and environment-friendly solutions. The ENERGIX programme has the primary responsibility for research and development to develop zero-emission solutions, while research and development on the use of such solutions on board ships belongs under the MAROFF programme.

Research Council funding for research on safety and security at sea will primarily be channelled via the MAROFF programme, with the exception of handling of acute emissions from offshore oil and gas activities, which is the responsibility of the PETROMAKS 2 programme.

Several Research Council programmes address challenges in the Arctic and northern areas, and cooperation with these may be of interest.

### *Infrastructure*

The Research Council's National Financing Initiative for Research Infrastructure (**INFRASTRUKTUR**) is a dedicated initiative for research infrastructure. Among other things, INFRASTRUKTUR funding has been used to upgrade the marine technology centre at Tyholt in Trondheim.

Norwegian companies need access to testing facilities to further develop their ideas from the conceptual phase to market-ready solutions. Siva, Innovation Norway and the Research Council of Norway have together established the *Norsk katapult* [Norwegian catapult] scheme, under which applicants can seek support to develop such facilities.

### *Centre schemes*

The Research Council administers several funding schemes for thematically oriented research and development centres. The **Centres of Excellence scheme** (SFF) is the Research Council's foremost instrument for enhancing the quality of research in Norway, while the **Centres for Research-based Innovation scheme** (SFI) promotes long-term research that fosters innovation in close collaboration between R&D-performing companies and prominent research groups. As of 2017, there are several centres with activities that lie within the MAROFF programme's area of responsibility. Some have a primarily maritime focus, including the Centre for Autonomous Marine Operations and Systems (SFF NTNU AMOS), the Norwegian Centre for Improved Energy Efficiency and Reduced Harmful Emissions from the Maritime Sector (SFI Smart Maritime), and the Centre for Marine Operations (SFI MOVE). Others have a combined marine and maritime focus, including the Centre for Research-based Innovation in Aquaculture Technology (SFI CREATE) and the Centre on Exposed Aquaculture Operations (SFI EXPOSED). The Norwegian Research Center on Mobility Zero Emission Energy Systems (MoZEES), which is funded under the Centres for Environment-friendly Energy Research scheme (FME), also works with research questions of relevance to the maritime industry.

### *Clusters*

Innovation Norway and the Research Council support various types of clusters under the Norwegian Innovation Clusters programme. The programme is divided into three levels: Arena, Norwegian Centres of Expertise (NCE) and Global Centres of Expertise (GCE), with the latter as the highest level. Several clusters conduct activities within the MAROFF programme's area of responsibility: the Arena Arktisk Maritim Klynge (equipment, design and processes for maritime operations in the Arctic), the NCE Maritime CleanTech (clean maritime solutions), and the GCE Blue Maritime Cluster (marine technology development and operations).

### *International cooperation*

The National Contact Point (NCP) for sea transport for the Societal Challenge on transport under Horizon 2020 is affiliated with the MAROFF programme administration. The programme administration takes part in meetings of relevant collaborative fora on maritime research in the EU on a regular basis, and is providing input to the coming work programme for transport in cooperation with Norwegian stakeholders.

The Research Council collaborates with the Maritime and Port Authority of Singapore on maritime research and development under a bilateral Memorandum of Understanding. A joint call for proposals was issued in 2015, and other joint calls may be issued in future.

The realisation of autonomous vessels in the deep sea segment will require changes in the international regulatory framework, and collaboration between the public authorities in Norway and other leading shipping nations will thus be of great importance. Autonomy technology for road transport is for the most part being developed in other countries, and there is potential here for technology transfer and international research cooperation.

Norway has world-class expertise in research on, and development and application of, enabling technologies in the maritime sector, but much of the research and development of basic technologies takes place in other countries. Norway must collaborate with leading international research groups to stay up-to-date on the research and technology front.

International RD&I cooperation is also vital for promoting greener maritime activities, particularly in connection with basic research and competence development and the development of standards and infrastructure for implementing and commercialising solutions.

## **7 Anticipated results, impacts and societal outcomes**

The MAROFF programme will provide support for research and development activities that help to increase value creation in the maritime industry within a sustainable framework by enhancing competitiveness, strengthening the capacity for restructuring and improving interactivity and knowledge transfer between the R&D community and the industry.

Projects in the various thematic priority areas will contribute to a varying degree and in different ways to achieving the overall objective of increasing value creation (see also the attached programme logic model). The MAROFF programme is one of several instruments being applied towards this objective, so measuring the impact of the programme on its own, particularly by thematic priority area, poses a challenge.

### *Results*

Most companies are concerned with value creation and competitiveness. They are also willing to invest significant resources in projects. The proportion of high-quality grant proposals received in a specific area will indicate to some extent how relevant each area is, and the MAROFF programme, are for the companies' development.

Indicators relating to grant proposals and to concrete project results will be used to assess whether the programme is on course in achieving its objectives. Indicators relating to grant proposals will be measured and assessed after the application review process is concluded and funding is awarded,

while indicators relating to innovation and research can generally first be measured once a project is concluded.

The programme will measure performance and input indicators for the programme as a whole and by thematic priority area:

- number and quality of grant proposals;
- new products/services (including business models), processes, methods, patents, licences and companies;
- research expertise (scholarly publication) and research capacity (number of doctoral and post-doctoral research fellows);
- proportion of projects with international partners and proportion of project costs covered by these international partners;
- number of H2020 proposals submitted on relevant topics with Norwegian participants and/or coordinators, and the success rate of these.

Maritime knowledge is vital to the development and application of technology in the ocean. The following indicators are relevant for assessing how the MAROFF programme bolsters the various ocean industries and addresses their common research questions:

- number of grant proposals distributed among the various ocean industries (sea transport, fisheries, aquaculture, offshore oil and gas, offshore wind power, new ocean industries and proposals addressing multiple ocean industries);
- number of grant proposals involving actors from multiple ocean industries.

The MAROFF programme is planning to announce funding for support for events, either with the aim of discussing new challenges and research tasks or disseminating research results. Performance indicators include:

- number of events;
- number of participants;
- number of presentations of relevance to the programme.

#### *Impacts and societal outcomes*

Maritimt Forum, an interest organisation representing the entire maritime sector in Norway, publishes an annual report on developments in value creation and employment in the sector (*Maritim verdiskapingsbok*). The order books for Norwegian shipyards give some indication of which ocean industries have the highest level of activity. There are many factors that affect these indicators, and the impact of the Research Council's contribution is unknown. Social and industrial indicators of this type can reveal information about increased value creation and restructuring within the industry, and must thus be assessed over time.

For the following thematic priority areas, specific indicators for project impacts have been defined:

#### *Autonomous and remote-controlled vessels:*

- number of planned or realised autonomous vessels featuring a significant amount of Norwegian technology.

#### *Promoting greener maritime activities:*

- emissions to air and water from new vessels constructed in Norway.

#### *Safety and security at sea:*

- number of accidents involving Norwegian vessels or in Norwegian waters.



On commission from the Research Council, the Møreforskning research institute regularly compiles a report measuring the performance of user-driven research, which can be used to assess how “successful” a MAROFF-funded project has been. The results of these measurements may in turn be used as a basis for assessing potential measures.

## **8 Resources and budget**

The MAROFF programme is an open-ended programme without a set completion date. The purpose is to achieve a programme that can realise its objectives by means of regular and predictable strategic, thematic and financial activity over a period of years, and thereby reach the targets established for the programme area.

The budget for the MAROFF programme for 2017 is NOK 169.3 million, with the entire amount allocated by the Ministry of Trade, Industry and Fisheries. This work programme is based on a zero-growth budget at the 2017 level. An annual, broad-based call for proposals encompassing the entire work programme will be issued each autumn. Additional calls for proposals or funding for specific application types may be issued in the spring as needed.

Funding will be awarded both to knowledge-building projects and to innovation projects that can help to realise the aims of the thematic priority areas described in this work programme. In certain cases (see section 5.1), calls for proposals may be issued for Researcher Projects or to award funding to targeted large-scale projects on specific topics.

Effort will be made to compile a portfolio in which 25–35 per cent of the funding is devoted to Knowledge-building Projects for Industry, Researcher Projects and/or targeted large-scale projects, while the remainder is devoted to Innovation Projects for the Industrial Sector. The distribution of funding among the various application types will depend on the quality of the grant proposals received.

## **9 Governance and organisation**

The MAROFF programme board is appointed by and reports to the Research Board of the Division for Innovation. The activities of the programme board must comply with the framework documents approved by the division research board, including the work programme, action plan, long-term budget and schedule for calls for proposals. The programme board’s activities must also be in compliance with the Research Council’s overall principles and guidelines for the operation of research programmes. The programme board is authorised to take the final decision regarding grant allocations to individual projects. The programme board acts on behalf of the Research Council in professional contexts within the framework approved for the programme.

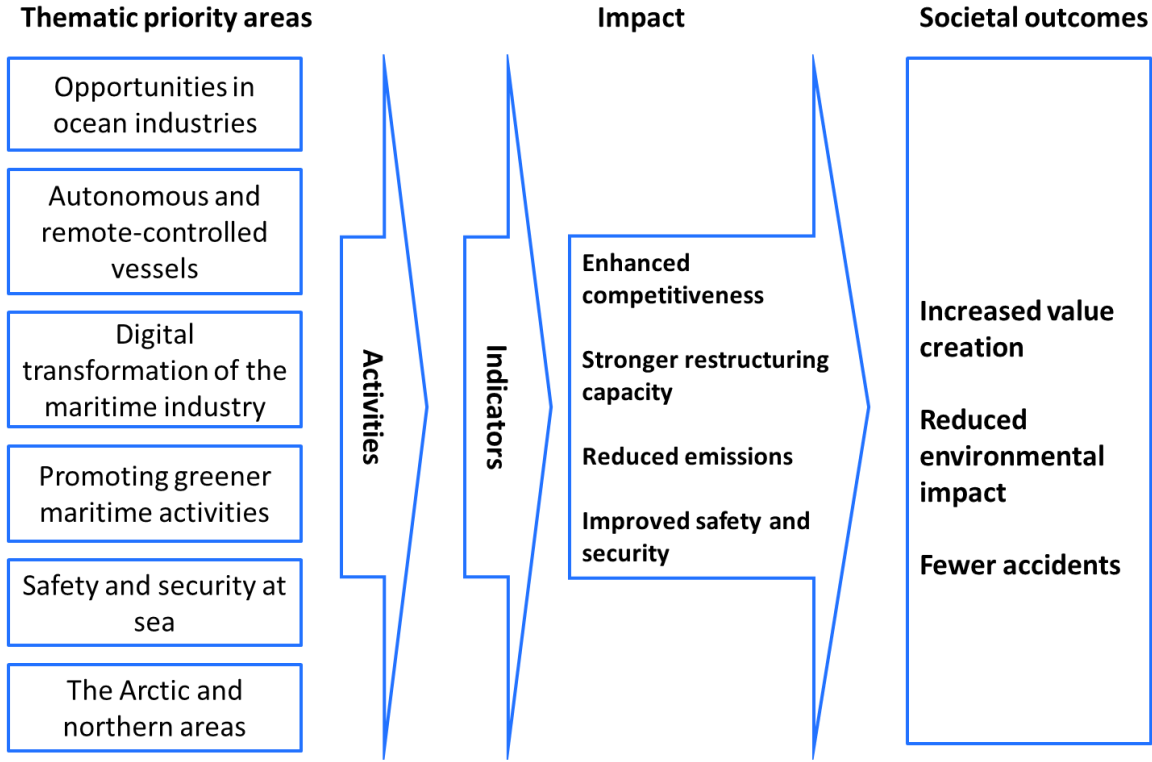
The MAROFF programme administration is responsible for carrying out the day-to-day tasks of the programme and consists of a programme coordinator assisted by personnel with scientific and administrative expertise.

# Attachment 1:

## Programme logic model

The MAROFF programme will provide support for research and development activities that help to increase value creation in the maritime industry within a sustainable framework by enhancing competitiveness, strengthening the capacity for restructuring and improving interactivity and knowledge transfer between the R&D community and the industry.

Projects in the various thematic priority areas will contribute to a varying degree and in different ways to achieving the overall objective of increasing value creation. Projects in some of these areas will primarily contribute by enhancing competitiveness, while projects in other areas will primarily contribute by strengthening restructuring capacity. In addition, projects in some of the areas will contribute to two other societal outcomes: reduced environmental impact and fewer accidents.



Different types of projects (application types) will also contribute in different ways to increasing value creation. Projects run by companies will generally contribute primarily by enhancing competitiveness and strengthening restructuring capacity, while projects run by researchers will contribute primarily by improving knowledge transfer.

