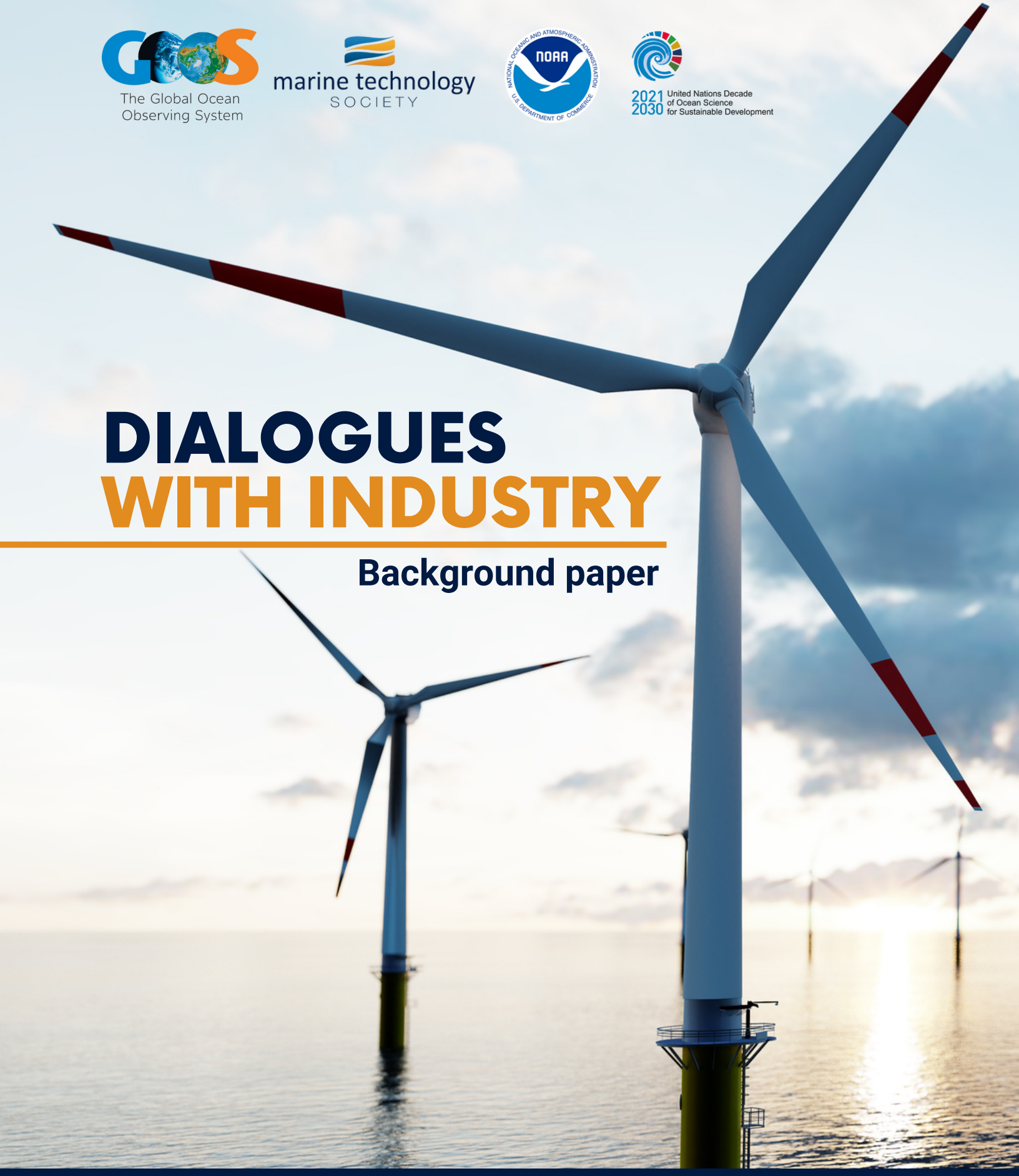
The Global Ocean Observing System

marine technology SOCIETY

2021 2030 United Nations Decade of Ocean Science for Sustainable Development



DIALOGUES WITH INDUSTRY

Background paper

Version 1
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DIALOGUES WITH INDUSTRY

Ocean Observing and the New Blue Economy

The purpose of this paper is to provide the rationale, background on the terminology, concepts of the ocean information value chain, and challenges and opportunities related to Ocean Observing as an emerging New Blue Economy market place. It should act as a starting point to understand the barriers to maturing the ocean observing market throughout the value chain, from the taking of observations to the delivery of information products and services to users, and provide specific, actionable recommendations that will help to unlock the economic potential and meet increasing demands of ocean information over the next decade.

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Introduction

A healthy and safe ocean is fundamental for productive marine ecosystems and thriving communities. The ocean regulates our climate and provides food security and livelihoods for billions of people, many of them in parts of the world that are facing grave impacts to their way of life due to climate change. The ocean is integrally and broadly linked to national economies, and the ocean economy itself is expected to top $3 trillion USD by 2030 (OECD 2016). In order to realise and maximise the potential of the ocean economy, it is critical to understand the physical, chemical and biological processes that drive ocean productivity and signal ocean changes through sustained global ocean observations. The collection, dissemination and use of this vital information necessitates engagement from a wide range of stakeholders, and there is substantial opportunity to advance and increase ocean observations to better meet societal needs.

There is increasing realization across the United Nations (UN) and national governments that ocean observations are key for achieving the UN Sustainable Development Goals (SDGs), such as SDG14 - life below water - and many others, including climate action, no poverty and zero hunger. The UN Decade of Ocean Science for Sustainable Development (Ocean Decade) has gained significant support with government, industry and philanthropy towards the “ocean we need for the future we want”, and it is clear that ocean observations are needed to meet the goals of the Ocean Decade. There is also a growing awareness and emphasis among governments about the important link between the ocean and climate change. The climate-ocean nexus is now included in the UN Framework Convention on Climate Change.

There are urgent and increasing demands for ocean information to address these twin imperatives - climate change and ocean management - that are driving market growth in ocean observing all along the value chain, from the taking of observations to the delivery of information services to drive policy and business decisions. Communities, government, and industry will need ocean information to navigate the future and meet the challenges posed by changes in ocean and weather patterns, and new data will be needed to inform decision making, risk assessments, and underpin sustainable growth. This represents opportunities for commercial companies to partner with governments to supply and coordinate infrastructure in order to grow the ocean observing system and the market for information products and services.

DIALOGUES WITH INDUSTRY

Today the sustained ocean observing systems and networks are heavily reliant on national/governmental funding, a major part of this from ocean science research budgets. This current funding model will not be sufficient to expand a sustained ocean observing system to meet the growing demands for ocean information. Furthermore, the global ocean observing system has lacked a market focus or view, which has inhibited the growth of private enterprise and the development of a more multi-sector ocean observing system that seamlessly integrates information from multiple instruments and providers across ocean variables. We need a paradigm shift towards a multi-sector integrated system, with backing and contributions from government, industry and philanthropic sectors (GOOS 2030 Strategy, 2019).

New commercial ocean observing services are already developing to exploit these new opportunities, and yet it remains unclear how this developing market and these commercial providers will interact and integrate with established global and national observing operations, as coordinated under the Global Ocean Observing System (GOOS, see Annex for description). There is also a growing awareness of the need to promote the maturation of this nascent market to foster further economic engagement for the advancement of commercial ocean observing platforms and networks. It is time to look at ocean observing as a growing marketplace and to understand where barriers to development lie, and what we could do to accelerate and mature this market to the mutual benefit of society, private and public sectors.

This necessary market evolution and paradigm shift towards a multi-sectoral ocean observing enterprise is both an opportunity and a challenge for the traditional, national government and academic, ocean observing system providers. In order to address the challenges and leverage the opportunities, there needs to be an active and vibrant dialogue between these actors, between industry, academia, philanthropic organisations and government about how to achieve a more efficient, dynamic and fit-for-purpose ocean observing system, and to maximise the strengths of all sectors in order to meet the demands for ocean information in this next crucial decade. Working together can result in a lower cost, more effective and sustained ocean observing enterprise, with a vibrant public and private sector engagement.

Key Concepts to Facilitate Effective Dialogues

This section briefly introduces some terminology and key concepts as a base to describe, discuss, navigate and advance this changing market landscape.

Terminology

The term "blue economy[1]" is one of the foundational concepts for discussing the role and value of ocean observations. While many definitions exist for the blue economy, the term often embodies the concept that the ocean is a finite resource, and that activities relying on the ocean can be both economically viable and sustainable. For example, "a sustainable ocean economy accounting for economic, environmental and ecological values whose activities and impacts are supported by the ocean ecosystems without threatening its resilience and health" (OECD, 2016). See **Table 1** for an overview of definitions.

There is not yet a consistent definition of market sectors associated with the blue economy, due in part to the relatively recent emergence of the 'blue economy' as a concept, but also the ongoing development of new blue economy industry sectors (e.g. marine renewable energy), and our advancing understanding of what sustainable ocean management will encompass. The sectors identified range from what has traditionally been considered the blue economy, including defence, marine transportation, oil and gas, and fisheries, to newer sectors such as those focused on renewable energy, and tourism.

Recently, the term "New Blue Economy" has been introduced to define a knowledge-based sector within the blue economy that generates value through information acquisition, derivation and sharing. The blue economy and the "New Blue Economy" are interdependent and a key distinction to understand the thinking behind this new sector, is that it the New Blue Economy is not only necessary to enable the extraction of tangible resources and critical services from the ocean (the blue economy), but that the ocean information itself is a critical driver of blue economic growth. This relationship is illustrated in **Figure 1**.

In addition, many other sectors in national economies are also dependent on information from the New Blue Economy. Defining this New Blue Economy sector within the blue economy enables a discussion around its economic potential.

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[1] The UN first introduced "blue economy" at a conference in 2012 and underlined sustainable management, based on the argument that marine ecosystems are more productive when they are healthy. The term was coined by the Belgian economist Gunter Pauli in 1994 - the Ocean-based Blue Economy is the next sunrise issue for development experts, he introduced this concept in the book – "The Blue Economy: 10 years, 100 innovations, 100 million jobs" in response to a United Nations request to prepare for COP3 in Japan where the Kyoto Protocol was decided in 1997

Table 1. Brief definitions of common terms, used in this discussion. This is not intended to be exhaustive or definitive, but helpful for maintaining a shared understanding.

Blue Economy	All economic activities of ocean-based industries and assets provided by marine ecosystems, with no reference to sustainability (World Bank).
Global Ocean Observing System (GOOS)	The intergovernmental program that coordinates ocean observing networks at the regional and national scales. The 3 focus areas for delivery are ocean health, climate, and weather and hazard warnings. See Annex.
New Blue Economy	Developed by NOAA in 2020 to describe a knowledge-based economy, looking to the ocean not for extraction of material goods, but for data and information to address societal challenges and inspire their solutions (Hotaling and Spinrad, 2021; Spinrad, 2016).
Ocean Architecture	TBD
Ocean Enterprise	Used to describe business activity that underpins making ocean measurements, observations and forecasts, and their subsequent use to deliver economic and societal benefits (NOAA, 2017).
Ocean Observing	Sustained observation (measurement) of ocean parameters or variables, often Essential Ocean or Climate Variables - EOVs and ECVs.
Ocean Observing Enterprise	Used to describe all business activities included in the Ocean Information Value Chain (see **Figure 4**).
Ocean Observing Networks	Refers to collaborative frameworks of people as well as observing technologies and data management practices from national, regional and local observing actions, that unite to deliver sustained ocean observing data. There are “global” networks where national/regional programs use common technologies to answer common questions and are coming together to share, learn, build capacity, and work to common data standards enabling interoperability where required (Moltmann et al 2019). Under GOOS the global networks have a global aim/design, e.g. Argo.
Value Chain	Adapted from the economics concept, to describe a framework for organising the ocean observing system into a series of subsystems each adding value with inputs, transformation procedures, and outputs, in a continual and iterative process (Revelard et al., 2022; Bahurel et al., 2010; Garçon et al., 2019; Pinardi et al., 2019)

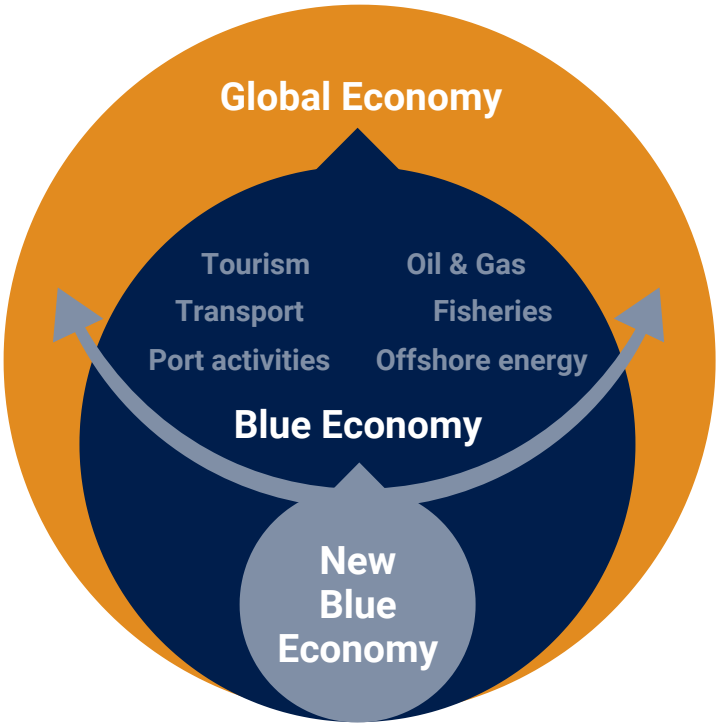

Figure 1. A sketch depicting how the New Blue Economy supports both the New Blue Economy and the Global Economy.

The Ocean Information Value Chain Concept

The ocean information value chain is used as a concept to illustrate how ocean observations are converted through a wide range of interactions, transformations and service delivery mechanisms to products that have value to decision makers and business leaders and thus impact to society (See **Figure 2** for a stylized example of the value chain). Taking the value chain approach allows us to illustrate the importance of ocean information and related services.

DIALOGUES WITH INDUSTRY

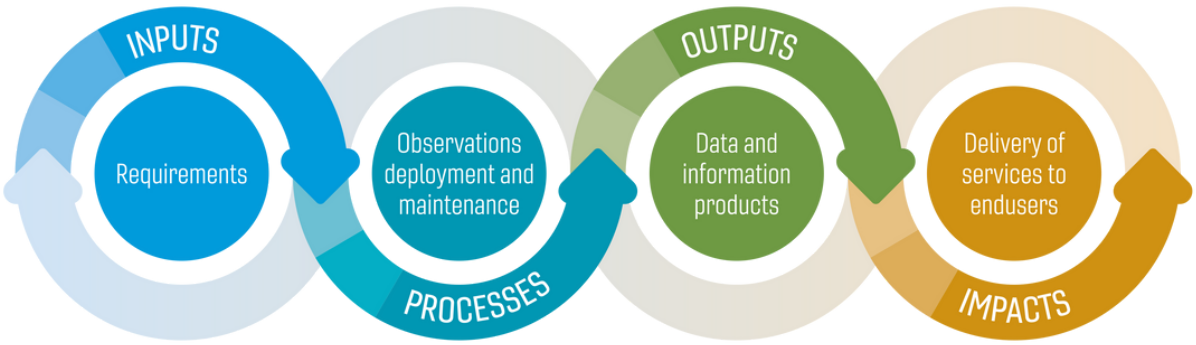

Figure 2. Value chain as defined in GOOS 2030 Strategy (2019). It is worth noting that although the value chain is illustrated in a consecutive manner to simplify the complex nature of these interactions, in real life there are feedback loops and communication channels between almost all of the elements pictured.

Within the broad concept of the ocean information value chain there are a large number of specific (ocean observing) value chains at varying levels of maturity (see **Figure 2**, GOOS 2030 Strategy, 2019). Some ocean observing value chains are now mature, for example the pathways from observation to weather forecasts, where real time ocean observations are delivered to the World Meteorological Organization (WMO) Global Transmission System (GTS) and from there incorporated by National Meteorological and Hydrological Services into numerical weather models for weather and hazard warning forecasts. Others are in their infancy, for example ocean carbon information services, where the observations, products, and the connection to government policy makers and carbon storage technology assessment are not yet in place.

The development of ocean observing value chains is driven by end-user needs. To give an idea of the broad range of these application areas, a cross-section of current and future ocean information users includes, the construction, insurance, retail sectors that use seasonal weather forecasts; citizens that use 7 day weather forecasts, aquaculture and offshore wind that want to site economic activity and monitor interaction with the marine environment; government policy makers that want to set carbon budgets and assess how marine carbon sequestration technology might function; communities that are facing increased inundation and other threats from cyclones and tsunamis through population growth and climate change; nations and communities that want to develop sustainable ocean economies, i.e. fisheries.

A Multi-Sectoral View of the New Blue Economy

While there is not currently a "global" picture of the Ocean Enterprise, there have now been several country-specific efforts to quantify and analyse this part of the economy at a national level. These works are reflected here, however there is a need for a more comprehensive picture to truly understand the market potential beyond national boundaries. In their studies of the Ocean Enterprise, the United Kingdom, United States and Canada have developed a taxonomy, following the ocean information value chain concept, to assess the size and economic impact of the Ocean Enterprise. These studies defined 3 broad segments of economic activity, from providers, through producers and intermediaries, to end users (see **Figure 3**). This value chain, similar to the Ocean Information Value Chain, is useful for illustrating and describing the opportunities for growth in the New Blue Economy.

According to NOAA (2021), the Ocean Enterprise in the US is valued at US$8 billion in annual revenue, experiencing a real dollar growth of 7% from the previous study completed in 2015, with the number of businesses growing by 60% to a total of 814 businesses. The 2020 Canadian study estimates the revenues of the Canadian Ocean Enterprise activities as between $1.1-$1.3 billion CAD (approx. $0.85 - $1 billion USD[2]) across 122 businesses. The United Kingdom Annual Review of the UK Marine Scientific Industry 2021 estimated the market size at £165 billion (approx. $1.95 billion USD[2]), which is a slight decrease from the 2020 figure, although this was expected due to COVID-19, with 79 companies responding to the survey.

The Ocean Enterprise assessments look at the business activity associated with the New Blue Economy, so below we show a combined public/private view of the marketplace, across the 3 sectors described for the New Blue Economy. The aim of this is to provide information on the current multi-sector New Blue Economy, in order to discuss trends and leading actors in each of these segments, and to provide a base for discussing the potential market opportunities in maturing the sector and to understand the barriers to development of an integrated multi-sector New Blue Economy - where commercial companies play a stronger role in delivering the GOOS.

[2] August 2022 conversion rate

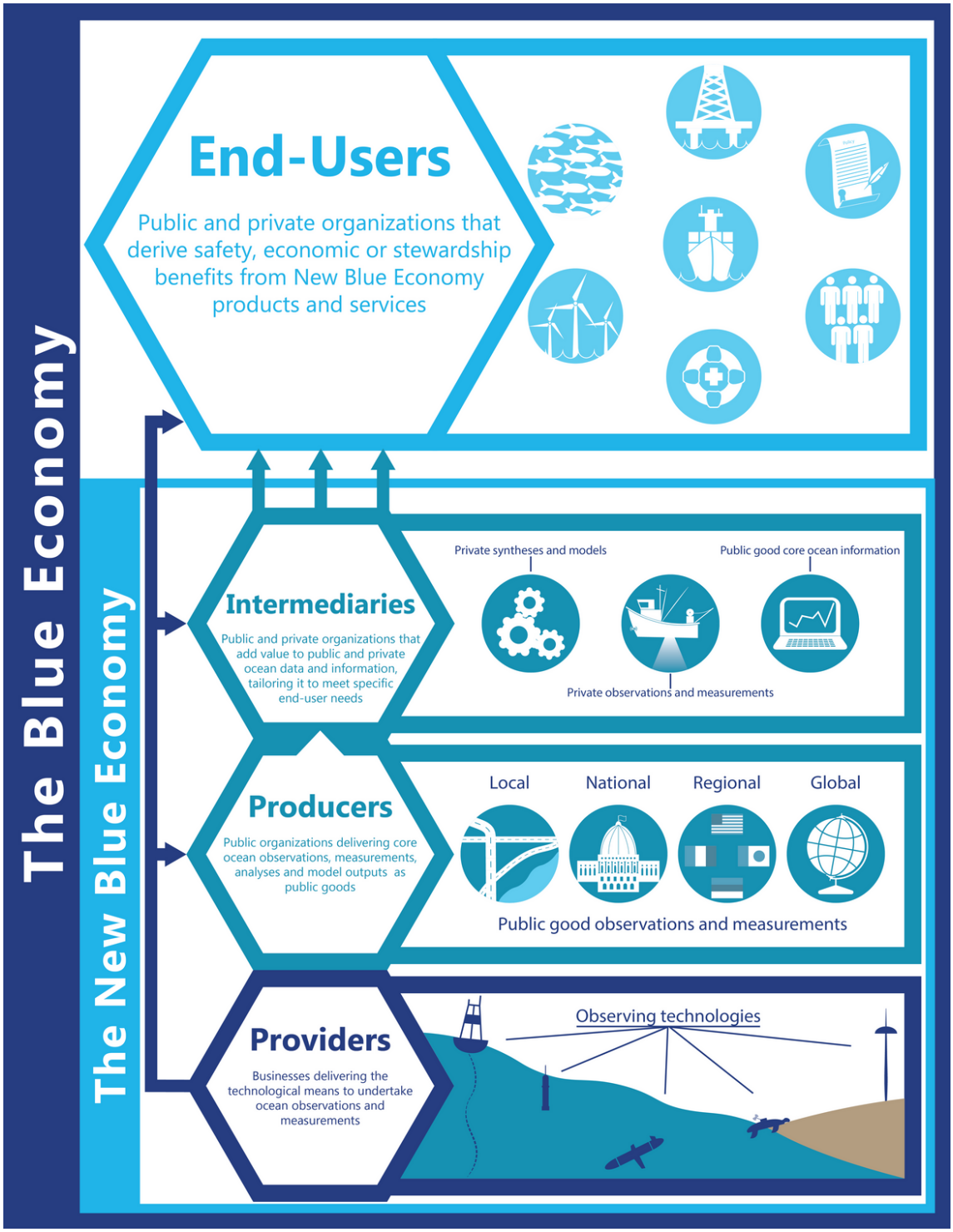

Figure 3. The principal components of the New Blue Economy (credit: NOAA)

DIALOGUES WITH INDUSTRY

Segment: Providers/Developers
Comprises: the manufacturers of technologies enabling ocean observations and measurements.
Current public and private engagement: Private sector supplies most of the technology for sensors, instruments and platforms, and makes up the majority of this segment. The public sector also develops new sensors and platforms for advancing ocean observing.
Size: Within the US Ocean Enterprise, most of the business (68%) identified themselves as providers and 14% identified that they perform both provider and intermediary functions (NOAA Ocean Enterprise Report, 2022). Interestingly, these statistics are similar to those in the first Ocean Enterprise study in 2016.
Trends: New instruments and sensors will be required to advance ocean observing and information for key societal issues, for example[3] around ocean carbon, tropical cyclone forecasting, marine biodiversity, marine heatwaves, storm surge and increased coastal observations for many issues, and including low cost solutions. Good potential for sector growth.

Segment: Producers
Comprises: the use of technologies to capture and manage ocean data.
Current public and private engagement: Public institutions are currently dominant in the collection and use of ocean information through ocean observing networks at multiple scales. For the most part, they share their data at no cost and make it available for use in commercial products. Under the Global Ocean Observing System (GOOS) there are 13 global ocean observing networks, including mature observing networks such as Argo, drifting buoys and voluntary observing ships, and emerging networks such as underwater gliders and high frequency radar. In addition, there are 12 developing Biology and Ecosystems (BioEco) observing networks, based around BioEco Essential Ocean Variables (EOVs). The GOOS Regional Alliances are coordinating bodies for regional ocean observing systems. These global and regional networks are predominantly supported through government funding at national, regional or local levels, mostly from ocean science research budgets and to a lesser extent through national meteorological agency funding. There is also some support from the philanthropic sector in the BioEco networks. Recently, this sector has seen increasing engagement from private industry, including the emergence of new business models that span the providers/developers and the producer sectors.
Trends: It is likely that the public sector will continue to play an important role there due to the remaining fundamental need for the provision of public good data and services. This sector is primed for public-private partnerships and for dedicated co-design activities to advance the production and use of ocean information.

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[3] Examples of focus areas to be addressed through co-design under the Ocean Decade - GOOS Ocean Observing Co-Design Programme

DIALOGUES WITH INDUSTRY

Segment: Intermediaries
Comprises: value added ocean information services supporting societal and economic benefits
Current public and private engagement: The US, UK and Canada Ocean Enterprise studies use this term exclusively as pertaining to industry. Presently, the public sector is playing a large role in the intermediary space. Many national and regional ocean observing systems offer value added data services, for example IOOS US, IMOS Australia, SOCIB in Spain. In addition, many countries have national ocean data centres that offer data services, for example INCOIS in India, BODC in the UK, and in Europe CMEMS (EU funded) provides in-situ and modeling data through one service. An emerging development to note is the work under the Ocean Decade towards Digital Twins of the ocean and the services that it is envisioned that will flow from these. The Ocean Enterprise studies indicate that there are relatively few businesses in this space, yet many opportunities to include, such as commercial consultancy services that provide services in modeling and analyzing observations to answer specific questions for private companies, for example in the oil, gas, renewable energy, port, desalination, and nuclear sectors, routing services for shipping, and situation room services to maritime search and rescue services. However, in general, this sector has relatively few commercial operators providing ocean data services to specific user sectors, given the range of potential users and the availability of data.
Size: This sector currently makes up only 32% of the Ocean Enterprise (NOAA Enterprise study, 2022), a slight decrease from businesses surveyed within the United States Ocean Enterprise study (2015).
Trends: There is a significant opportunity to deliver more and more targeted ocean information data and services to societal sectors that will need these products and services. The data is increasingly well organised and available, the private sector has expertise in customer development, AI, big data, etc. There is sound potential for growth as new data delivery technologies are implemented and societal demand for ocean information grows.

Figure 4 combines and provides an overview of the Ocean Information Value Chain and the Ocean Observing Enterprise. It shows the different elements of the value chain and provides the content that they cover in more detail. It also shows the partners in the value chain that interconnect to deliver information to end-users, who in turn derive socioeconomic and economic benefits from these information products. Private and public organizations as well as public-private partnerships on a local, national, regional, and global level can contribute to any number of these elements according to the nature of their organization, i.e., through commercial products, public services, data collection and provision, and philanthropy. There is a requirement for innovation as well as business opportunities within all of these elements. A return can be gained from investments both within and across components, as indicated by the estimated relative potential growth of each component.

DIALOGUES WITH INDUSTRY

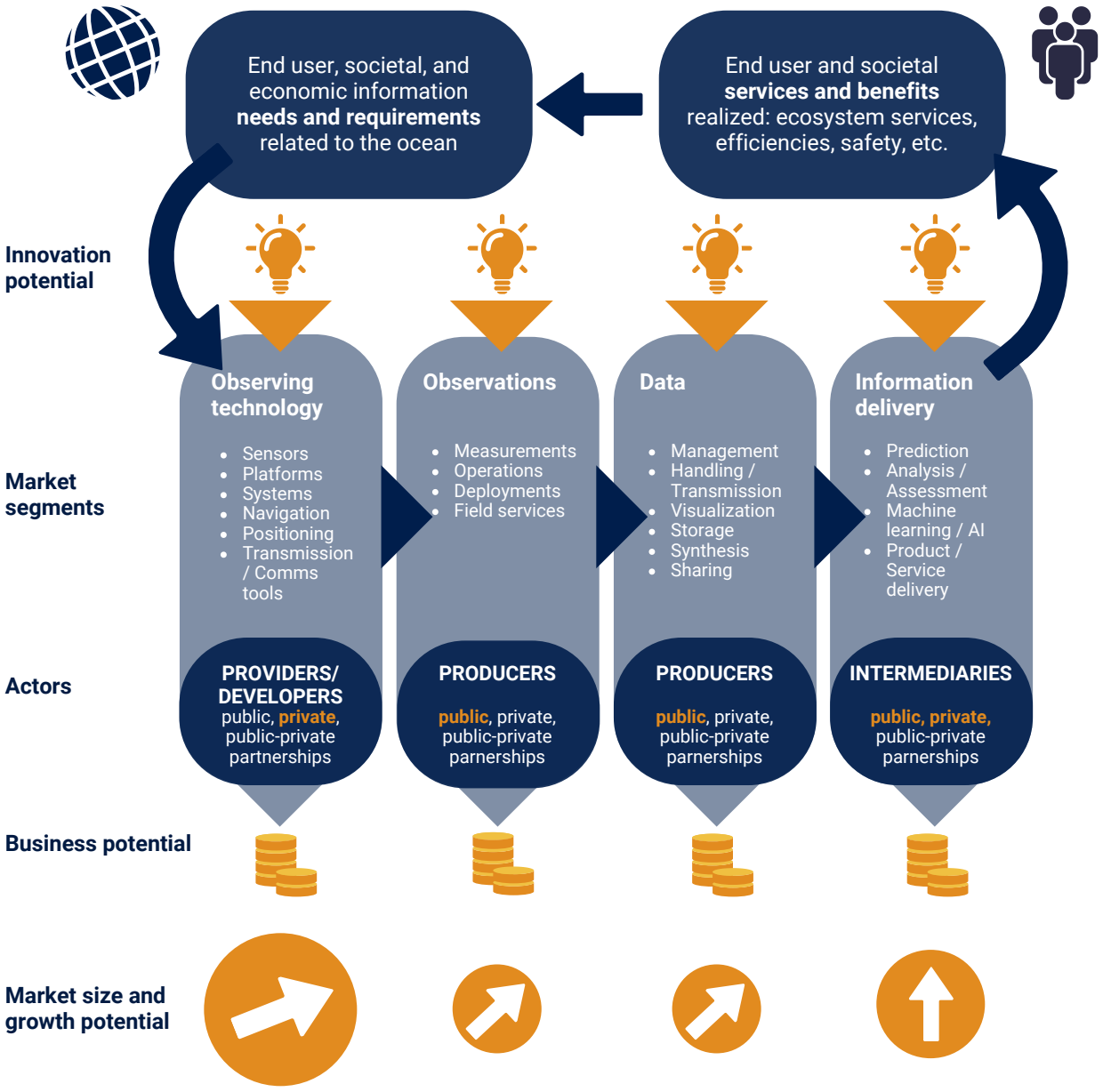

Figure 4. The Ocean Information Value Chain for the ocean observing system with its different market segments, showing the major actors in each segment and examples of different elements in the segments, e.g. the observing technology segment is populated by providers and developers that are mainly from the private sector. The orange discs visualise the current level of industry involvement in the segment, i.e. they offer an estimate of the relative market size. The arrows indicate our estimate of growth potential in each area (horizontal - low, vertical - high). All sectors can benefit from innovation and can be commercially exploited.

Maturing the New Blue Economy

The ocean observing landscape is changing. As the demand for ocean information increases, new business models emerge and there is increasing recognition by the financial community, governments, and the UN that the ocean and the blue economy are profitable areas for investment. With clear societal drivers for market growth, as well as increasing private and financial sector interest in further development, we are poised for change, however there are barriers to this growth and some anxiety in the public sector that commercial involvement will lead to a deterioration of data quality and availability.

To date, as already noted, the ocean observing system has been largely funded by government and operated by public entities, which has led to an ocean observing system made up of a diverse range of organisations, which is then coordinated through global organisations like GOOS. Within this diversity is a strong element of innovation, however as a market the system is highly fragmented, with each element contributing to a global system. Each country that contributes to the global system invests in its national infrastructure. Under GOOS there are best practices, FAIR[4] data principles, networks, systems, structure and infrastructure, however outside the ocean observing community this is not necessarily visible, easy to navigate, or understand. This fragmentation is one of the barriers to some of the benefits in terms of cost and scale that increased market maturity can bring.

To create a vibrant public/private partnership across the ocean information value chain, which supports societal outcomes, private sector growth, and government aims, we need to look at these opportunities, barriers, and concerns, as well as the benefits of a more mature New Blue Economy.

In **Table 2** we outline some of the known issues experienced by both the ocean observing community as producers of observations/data and the providers of technology and services[5].

[4] Findable, Accessible, Interoperable, Reusable

[5] Sources; as reported by the global networks to the GOOS Observations Coordination Group (implementers), and from discussion with industry partners in the development of this background paper.

Table 2. Challenges experienced by the ocean observing community and the suppliers.

Producers (observations/data):	Providers (technology and services):
• No efficient/internationally recognised way to fast track promising technology to fill identified gaps/global needs, and from other sectors • High unit costs • Sub-standard and variable manufacturing quality and factory calibration • No universal standards • Long-term product support and maintenance • Promising technology in other sectors could be adapted, but unit numbers too small • System resilience/low flexibility with limited suppliers serving other markets and long and/or fragile supply chains • Budget to meet the ambitious spatio-temporal observing demands	• No consistent forward view of global ocean observing system technology needs • Lack of visibility of market potential and a fragmented market - low order numbers at a time, need to work with many different individual users, despite the global market size • Users asking for different and specific configurations, developments, and adaptations • Lack of visibility of research and development efforts in university and government programs that do not partner with industry; also, duplication of development work within different countries • Interaction of new commercial networks and services with established operations is unclear

Fietzek, P. (2021) discusses the benefits of a matured ocean observing market and suggests inter-sectoral collaboration to grow value in the system. Examples for such collaboration to help mature the market, in this case through efficiency gains, could be initiatives to establish or increase the flow of relevant information, i.e. of observational needs, market potential, technical demands, innovation activities, between providers and producers. Maturing the market would help overcome the challenges still present in the field and enable exploiting the benefits for all involved stakeholders and sectors.

In **Table 3** we provide some of the potential benefits of finding practical solutions to issues raised and enhancing opportunities for the private sector to partner and participate in GOOS.

DIALOGUES WITH INDUSTRY

Table 3. Benefits to private industry, public sector and society.

Private sector (providers, producers, intermediaries)	Observing system implementers / government (producers, intermediaries)	Society

• Enhanced market clarity and planning capacity:
  ◦ Engagement of larger industrial companies
  ◦ Growth (small and medium) businesses
  ◦ Economic stability, eases investment
  ◦ Larger orders
• Enhanced manufacturing efficiency through implementation of large scale industry processes
• Increased demand for technological innovation
  ◦ Exchange between manufacturers and users
  ◦ Faster innovation
• Opportunities to offer added services e.g. equipment rental, insurance, data processing, etc.
• Operational observing sector will grow
	• Industrialised products specifically designed for the applications:
	  ◦ Drop in cost per data point ratios (lower product price, larger production longer deployments, higher measuring frequencies)
	  ◦ Improved ease of operation, user-friendliness and reliability
	  ◦ Application of common protocols and standardised interfaces
	• Community negotiates favourable conditions through consolidation of orders
	• Faster innovation
		• Increased knowledge and ocean observing enabled information products - increased data flow to support blue economy, achieving SDGs, hazard warnings, weather, climate
		• Thriving and growing New Blue Economy
		• Cost savings, greater efficiency, and Return on Investment (ROI)
		• Faster progress and technology to market
		• Increase in sustained ocean observing system capacity globally
		• Hybrid system that delivers strongly to societal outcomes

DIALOGUES WITH INDUSTRY

Moving Ahead through Inter-Sectoral Dialogue

To evolve toward a fully multi-sectoral ocean observing system, composed of public and private investment, we need to address the opportunities and challenges across each of value chain segments, develop a deeper understanding of the benefits of this evolution, where we should prioritise change, what can the various actors practically do, and any areas where caution should be applied. Inter-sectoral dialogues conducted in a neutral and comprehensive way, backed by organisations that can act on the recommendations that are developed are a first and promising step. Four initial discussions are planned in 2022 to follow the ocean information value chain, as laid out in this paper, and include:

- Provision: Supply and development of sensors and platforms
- Multi-Sectoral Ocean Architecture: Integrating new observing networks and business models
- User Driven Ocean Information Services: Core and downstream services
- Looking ahead: New technology for the Ocean Decade

Real change will come from a dialogue between the different entities, national government, intergovernmental, academic and the private sector, the uncovering of practical solutions, and reaching an implementable set of recommendations that the actors involved will work to implement. The cooperation between GOOS, MTS and NOAA towards fostering a dialogue and supporting the implementation of the recommendations is a key strength in achieving it.

Annex

Collaboration behind the Dialogues with Industry
This paper is a prequel to the actual "Dialogues with Industry", its aim is to explain some of the concepts and thinking behind the Dialogues. The ideas and approach to the Dialogues with Industry has been the result of real life experience of the issues noted within the paper by the GOOS networks and discussion with industry partners about how to resolve these. There has been a strong willingness to engage and work together to explore potential solutions. However, there was an early recognition that for 'system' change a broader dialogue was needed and a means to structure the dialogue. GOOS, MTS and NOAA joined forces with government and industry partners to look at how to shape this and formed the Industry Dialogues Planning Committee. The members of the committee, listed here, have been working cross-sector for the last 18 months to develop these concepts and refine the questions, issues and approach. We hope you find this background Briefing Document useful - the Industry Dialogues Planning Committee.

Additional background on GOOS
GOOS coordinates across ocean observing networks, and regional and national systems that gather in situ data from the open ocean and more coastal areas. Since 1993, GOOS has led the ocean observing community and interfaces to the UNESCO Intergovernmental Oceanographic Commission (IOC), World Meteorological Organisation (WMO), UN Environment.
GOOS vision is for 'a truly global ocean observing system that delivers the essential information needed for our sustainable development, safety, wellbeing and prosperity' - GOOS 2030 Strategy. This vision cannot be achieved without strong partnerships along the 'value chain', from technology development and production to, observations, through data management, prediction and assessment, and to services to users, and with a broader range of actors, including the commercial sector.

Examples of trends in two traditional Blue Economy Sectors
There is reliance on ocean information across the entire Blue Economy (Jolly et al., 2021, Hermes et al., 2022). Brief notes on two sectors, marine transportation and fisheries, are provided as examples of how ocean information is supporting and evolving the blue economy.

The world's 60,000 ocean going cargo ships are operated by some 1.6 million seafarers, traversing the globe and carrying 11 billion tons of trade annually which represents 80% of global trade. High winds, waves, fog, and storms can be encountered on every voyage. Casualty statistics show that "bad weather" is a contributing factor in one in five ship losses. Ways to improve accuracy and timeliness of weather forecasting and its transmission are vital, and key areas for urgent attention have been identified, including the need for maritime users to better understand meteorological and ocean data. In India, prediction of the intensity of the storms enabled port authorities to adopt measures for just in time evacuation resulting in at least 3 days of productivity per year for the major ports in Eastern Coast.

A growing demand from funding agencies and the public for sustained fishing practices and growth in the use of ocean data to support the fishing community are supporting change in fisheries. Examples of where ocean information is supporting ecosystem-based fisheries management are: NOAA's fisheries oceanography program on ocean conditions for salmon returns using plankton species, SST and DO, the work of regional ocean observing and forecasting system SOCIB in Spain for regional tuna fish spawning (Alvarez-Berastegui et al., 2016), in Peru the Fishermen Association is now using CTD data, and the Indian National Centre for Ocean Information Services has shown the benefit of potential fisheries zones using ocean data (Venkatesan et al., 2017) - an economic analysis indicated that the real growth rate of gross value added in marine fisheries GDP in India can go up to 7.8 % per annum if Potential Fisheries Zone and ocean state forecast advice is operationalised and an additional profit for fishing community of around $4 million USD – and, in Japan the Fisheries Ministry has started funding ocean observations.

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The Global Ocean Observing System

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DIALOGUES WITH INDUSTRY

Background Paper
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