Harnessing Ireland’s Potential
as a European and Global Centre for Ocean Technologies

Inspire – Initiate – Innovate
Acknowledgments

This strategy has been developed by a team of representatives nominated at an industry led meeting held in NUI Maynooth in July 2009 to discuss the development of the SmartBay Galway project and related ocean technology opportunities. The meeting was attended by 47 individuals representing 18 companies, 8 public agencies and 8 academic research centres and they nominated the following representative to prepare this strategy on behalf of the larger group.

Smart Ocean Strategy Working Group

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This group met 4 times between September 2009 and March 2010.

Smart Ocean Innovation Cluster Strategy - Report Drafting Team:

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Special thanks to Mike Devane, Geoffrey O Sullivan, Paul Gaughan, Felicity Donnelly, Glenn Nolan, Guy Westbrook and to all the members of the Smart Ocean Strategy Working Group for additional assistance and support.
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Executive Summary

The aim of this Consultation Document is to outline a Vision and present a Strategy to create a SmartOcean Innovation Cluster which will establish Ireland as a European and Global Centre for Innovative and Specialist Ocean Technologies.

Vision 2020

By 2020 Ireland will be a recognized leader in the development, testing, commercialization and delivery to market of the next generation of innovative technologies addressing evolving global markets in marine renewable energy, environmental monitoring and water technologies.

Accepting the challenge of the Innovation Task Force (2010), for the need for an ambitious game changer to secure Ireland’s economic future, the SmartOcean Strategy Working Group poses a challenge to our Entrepreneurs, SMEs, Multinationals, Industry bodies, Academia, State Agencies, Government, Venture Capital, and even the Media and Public, to answer the question:

Can Ireland address major global challenges and emerging market opportunities by utilising our unique Ocean Resource as a catalyst for innovation building on our existing Knowledge Economy Clusters in ICT and Life Sciences?

Ireland’s Ocean Territory is its greatest natural resource, encompassing a wealth of tangible assets. Ireland has made serious investments in the creation of intangible assets i.e. the intellectual property and know-how of our existing ICT Innovation cluster and other clusters such as life sciences and medical devices. The strategic intent of the SmartOcean Innovation Cluster is to combine these assets utilising the Ocean as a catalyst for innovation in a way similar to the way in which other nations have used the oil and gas, shipbuilding or the defence sector to drive knowledge and innovation.

The SmartOcean Innovation Cluster will initially target newly emerging niche areas (e.g. marine renewable energy, environmental monitoring, water management) as well as established markets (e.g. oil and gas, aquaculture, maritime transport, tourism, coastal erosion etc.) by developing science-based innovative and competitive production systems and service models to target niche, high-value and high-growth international export markets.

It will build on existing partnerships established between specialist research institutes, innovative SMEs and MNCs, and facilitate the convergence of expertise in areas where Ireland has a strong and internationally recognised capability (e.g. informatics, communications, sensors, software, control systems, mechanical engineering and materials science) with areas where Ireland has strong marine science expertise. The partnerships and
projects established to date have already produced impressive results, including the development of new products and services, securing of FDI investment and international research funds.

The intention is that the existing SmartOcean Innovation Cluster stakeholders will work collaboratively to:

- realise the full potential of the significant investments to date in R&D;
- create a profile for Ireland as a cutting edge location for carrying out research into specialist ocean technologies, leveraging convergence opportunities;
- leverage market intelligence and our international alliances and networks;
- commercialise innovative ocean technologies, targeting niche elements of the value chain associated with emerging marine and environmental markets;
- operate new commercial entities and public private partnership models to capture market share and address global market opportunities requiring a collaboration between technology developers, systems integrators and solutions service providers and government;
- create economic value and jobs recognising the needs of and contributions which coastal communities can make to diversifying their existing industrial base; and
- promote education and training and public awareness of the value of the oceans.

Critical to the creation of the SmartOcean Innovation cluster is the consolidation of a core suite of test bed infrastructures. These will provide the key enabling framework and represents an essential contribution by policymakers to support and influence the cluster foundation.

Ireland will operate an internationally recognised, co-ordinated network of SmartOcean Infrastructure (deep water seas, bays, inlets, catchments and rivers) designed to attract companies and research groups to test a diverse range of new technologies and real-time streaming communications capabilities.

Ireland’s SmartOcean Innovation Cluster will differ from established international maritime clusters in seeing its technological core in sensors, communications, data management, software, control systems, mechanical engineering and materials.

This Consultation Document is being launched at a special Workshop: “Towards a New Horizon: Harnessing Ireland’s Potential as a European and Global Centre for Ocean Technology” held on 22nd – 23rd March 2010 at the Marine Institute Headquarters, Galway.

Submissions are invited from all interested parties (see details at: www.marine.ie/home/smartocean).

The Marine Institute will publish the outcome of this consultation process in May/June 2010.
I Introduction

The world’s oceans, covering over 70% of the Earth’s surface are, in fact, a single contiguous body of water encircling the globe. From Arctic ice through the North Atlantic to the warm equatorial waters to the Antarctic Circumpolar current all the Earth’s oceans, seas, bays and inlets are connected. Consequently an ocean challenge is a global challenge and an ocean opportunity is a global opportunity. Ireland has an ocean territory ten times the area of our landmass and possesses a unique Atlantic footprint. We are strategically positioned on the western periphery of the European Union, abutting the important Gulf Stream, at the Boreal-Lusitanian Divide, separating important southern and northern commercial fisheries, and in one the world’s greatest hotspots for offshore wind and wave energy. This unique geographical position makes Ireland an ideal location for a European and Global Centre for ocean research, technology and innovation.

The aim of this Consultation Document is to stimulate dialogue and feedback on the current potential that exists to establish a flagship innovation project – the SmartOcean Innovation Cluster.

The strategic intent is to build on the existing ICT cluster and our science and technology base and link this to our largest natural resource – the Ocean – using it as a catalyst for innovation in a way similar to the way in which other nations have used the oil and gas, shipbuilding or the defence sector to drive knowledge and innovation.

Vision 2020

By 2020 Ireland will be a recognized leader in the development, testing, commercialization and delivery to market of the next generation of innovative technologies addressing evolving global markets in marine renewable energy, environmental monitoring and water technologies.

In line with this Vision:

- Ireland will operate an internationally recognised, co-ordinated network of SmartOcean Infrastructure (deep water seas, bays, inlets, catchments and rivers) designed to attract companies and research groups to test a diverse range of new technologies and real-time streaming communications capabilities.

- Ireland’s SmartOcean Innovation Cluster will differ from established international maritime clusters in seeing its technological core in sensors, communications, data management, software, control systems, mechanical engineering and materials.
• The SmartOcean Innovation Cluster will emerge as a catalyst for innovation taking advantage of Ireland's unique Atlantic Ocean footprint. The **ICT cluster** is expected to be the initial driver of the SmartOcean Cluster enabling significant advances in terms of communications technologies, sensor technologies and real-time information acquisition, interpretation, and forecasting applied to targeted markets.

• It is also envisaged that the **unique biodiversity** of Ireland's Ocean territory, combined with Ireland's Life Science clusters in both biopharma and in medical devices, will yield exciting future opportunities.

• European and International companies and agencies will be working continually in **prototype testing and collaboration** with Irish based companies and research institutes addressing emerging markets (marine renewable energy, environmental monitoring, climate change, water management) and new innovations in the established markets of oil & gas, shipping & transportation, aquaculture, seafood, fisheries and coastal tourism.

• A cohort of new entrepreneurial SMEs will emerge taking advantage of the unique opportunities offered in growing markets and the nascent cluster formation. As concrete indications of the SmartOcean Innovation Cluster evolution become apparent in 2015, growing **international interest, venture capital and supporting financial and legal interests** will transition from talk to action, boosting the cluster intensity.

• The SmartOcean Cluster will attract to Ireland some heavy industry international players and a growing cohort of indigenous players providing **ruggedized ocean capabilities** in support of the information, sensor, and communication technology cores.

• Universities & Research Institutions will see a growing number of their **research projects** converging on the ocean technology agenda and joint projects with industry being tested on Ireland’s SmartOcean Infrastructure

Clusters are traditionally established around a group of firms, related economic actors and research institutions that are physically located near each other and have reached a sufficient scale to develop specialised expertise, services, resources, suppliers and skills. The SmartOcean Innovation Cluster extends this concept to **include access to associated ocean innovation test platforms where new concepts, equipment, solutions and services can be tested in real life situations.**
The SmartOcean initiative advances the vision and objectives set for the Advanced Marine Technology Programme in Sea Change 2007-2013. The Cluster seeks to build on existing partnerships established between specialist research institutes, innovative SMEs and MNCs involved in the SmartBay, SmartCoast and Smart Catchment Projects (funded by the Marine Institute and EPA). As part of the implementation of the Sea Change Marine Technology Programme, the Marine Institute has led a loosely co-ordinated clustering initiative, bringing together partners whose skills, expertise, products and services are not traditionally associated with the seas and oceans. It has, in a short period, produced some impressive results highlighted below.

### Advanced Water Management - SmartBay
In June 2008 IBM choose Ireland to launch its ‘Centre for Excellence in Water Management’ whose remit is Marine, Costal and Smart Catchments. Working with the Marine Institute via the SmartBay Pilot Project, IBM has developed “end to end” reference architecture with large scale commercialization potential to support their Smart Planet Strategy. This demonstration project showcases IBM’s capabilities on the world stage, highlighting the commercial potential for extracting intelligence from sensors and devices and generating new intelligence from the interconnectedness of these devices and new paradigms in analytics. This is a classic example of the kind of added value activity needed to further embed multinationals into Ireland.

### Innovative Communications Testing – SmartBay
Intel has partnered with the Marine Institute, ComReg, NUI Maynooth, HEANET, Techworks Marine and Lighthouse Networks to undertake marine trials of WiMax - a new high speed broadband technology across Galway Bay. The ‘over water’ aspect of this undertaking is critical and represents one of the first Mobile WiMAX ‘over water’ deployments worldwide. In 2010 Intel plan to install and test the performance of a WiMAX base station in Spiddal to provide high speed wireless communications at the Wave Energy test site located offshore.

### Sensor Commercialisation – Smart River
EpiSensor - an Irish SME is working with DCU and IBM to commercialise a phosphate sensor developed by DCU researchers through a project jointly funded by the Marine Institute and EPA (building on previous investment from SFI and Clarity). Building on this project, IBM and EpiSensor are now collaborating to develop real-time, environmental monitoring solutions for energy, water and carbon management. EpiSensor is a global leader in wireless sensor network technology and is combining its expertise and know-how in developing environmental monitoring solutions with IBM’s research, enterprise software, advanced modelling and complex network management abilities.

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### Novel Sensing – Smart Coast

Luxcel Biosciences in conjunction with UCC have applied their technology systems to the analysis of water quality under a joint initiative funded by the EPA and Marine Institute. The core technology provides innovative methods to replace traditional approaches to toxicity screening that are tedious, inefficient and expensive. In a recent development, Luxcel entered into a strategic partnership with MOCON Inc. a global leader in gas sensing technologies and package testing/shelf life instrumentation for the food, beverage, pharmaceutical and other industries. Mocon has invested €2.5m in Luxcel and the two companies have entered into a strategic partnership which allows Mocon to develop and market instruments which use Luxcel's sensor technology.

### Climate Change Analysis – Smart Catchment

RESCALE - Review & Simulate Climate and Catchment Responses at Burrishoole is a multi-partner project involving the Marine Institute, NUI Maynooth and Trinity College Dublin. Using the unique 50 year Marine Institute environmental dataset the project was designed to analyse, evaluate and integrate environmental data with high-resolution climate models to assess the likely changes in key aquatic processes in the catchment.

### Real-time Monitoring and Sensor Network Development – Smart River

DEPLOY - Long-term Deployment of Sensor Monitoring System is a technology demonstration project which aims to show how state of the art technology can be implemented for cost effective, continuous, real-time monitoring of a river catchment. DEPLOY represents an important collaboration between the National Centre for Sensor Research, Tyndall National Institute, IDS Monitoring, EPA and the Marine Institute with the outputs from the project leading to improved monitoring and management of water bodies creating considerable interest in Ireland and internationally.

By facilitating the convergence of expertise in areas where Ireland has a strong and internationally recognised capability (e.g. informatics, communications, sensors, software, control systems, mechanical engineering and materials science) and linking these with traditionally strong marine science expertise, Ireland can produce new products and services for global export markets.

The SmartOcean Innovation Cluster (proposed in this document) seeks to target newly emerging niche areas (e.g. marine renewable energy, environmental monitoring, water management) as well as established markets (e.g. oil and gas, aquaculture, maritime transport, tourism, coastal erosion etc.) by developing innovative and competitive production systems and service models to target niche, high value and high growth international export markets.
This Consultation Document is being launched at a special Workshop: “Towards a New Horizon: Harnessing Ireland’s Potential as a European and Global Centre for Ocean Technology” held on 22nd – 23rd March 2010 at the Marine Institute Headquarters, Galway.

Submissions are invited from all interested parties (see details at: www.marine.ie/home/smartocean)

The Marine Institute will publish the outcome of this consultation process in May/June 2010.
2 The Ocean Opportunity

2.1 The Global Oceans

The global ocean is critical to the Earth’s ecosystem function and central to our continued well-being and the prosperity of the human race. The seas and oceans represent important trade routes, are a climate regulator and a source of food, energy and recreation. Technology and know-how allow us to extract ever more value from the sea and more and more of the Earth’s population is located on the coast.

New knowledge, technology and innovation bring new opportunities to further develop traditional marine sub-sectors (e.g. fishing, aquaculture, seaweed, shipping, tourism, oil and gas).

New knowledge, technology and innovation also open up exciting new opportunities such as the use of marine biological/chemical resources in drug development, biomedical devices, food ingredients (the knowledge-based bio-economy) and industrial chemicals, development of renewable wave and tidal energy sources and the application of ICT and engineering technology to environmental monitoring and new service based and internationally traded sectors.

While we are hugely dependant on the oceans for our well-being and prosperity, we are also witnessing a decline of the ocean’s vast resources through pollution, habitat destruction, over-fishing, global climate change and ocean acidification. Indeed, the ocean’s capacity to create life is now rivaled only by our capability to destroy it. The need to understand and manage our oceans has never been greater and increasingly requires accurate and timely information on climate, weather, water, ecosystems, biodiversity, energy resources, and natural disasters. Technology has a key role to play in the provision of this information and to underpin the development of new commercial opportunities associated with our marine environment and the sustainable management of ocean resources. **The question is no longer solely one of Ocean Science but one of Ocean Innovation.**

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2 An Ocean of Opportunity, EU 2008
3 Acid Test: The Global Challenge of Ocean Acidification www.ndrc.org
2.2 Ocean Innovation - A Game Changer for Ireland?

The pace of global change is accelerating and seismic shifts are taking place in both the competitive and cooperative landscape among nations. Pervasive communications technologies and growing world travel are enabling a truly global supply chain of people, information, products and services. Around the world countries are re-evaluating how to best leverage their capabilities, assets and natural resources and against this dynamic backdrop are faced with ever more porous national borders.

Many nations, both developed and developing, have undertaken Technology Foresight exercises, the outputs of which have often pointed the way towards the creation of innovation clusters as the future drivers of their economies. This is particularly true for countries low in natural resources, such as (is perceived to be of the case) of Ireland, and with limited local markets, where human capital is the primary resource and global out-reach is a necessity. In the case of Ireland, our strategic focus is centred on Information & Communications Technologies (ICT) and on Life Sciences (biotechnology & medical devices). We have recently broadened this focus to Energy, Environment and Clean Technologies.

Ireland is certainly not unique in its chosen set of foci and many countries have similar strategies. Lacking the safety-net of natural resources, for Ireland this has been seen as a one-way bet. It is in the objective of this consultation document to challenge and channel a rethink – not of strategy – but of orientation. Why? Because Ireland has a very significant natural resource – it’s Ocean Territory.

Ireland’s Ocean Territory extends to 220 million acres and encompasses a wealth of natural resources. Over the past 10 years the Irish Government has funded the largest civilian seabed mapping project in the world in a project jointly undertaken by the Geological Survey of Ireland and the Marine Institute. Work continues to map the full extent of the physical, chemical and biological features of the seabed to enable the sustainable economic development of Ireland’s most significant natural resource.  

4 The Irish National Seabed Survey and INFOMAR programme
A recent review of the Seabed mapping initiative, carried out by Price Waterhouse Cooper (2008) noted that the value of benefits accruing to the knowledge economy from this dataset alone would be in the region of €240million. The project has enabled the build up of a unique expertise and knowledge base to support companies and researchers to generate a range of new products and services.

While not Ireland’s situation, it is well recognised that the defence sector, including the naval services and related activities, have been central to innovation in several countries. The US, for example, has achieved dominance in many high tech markets as a result of cross-subsidisation of civilian technology by investments in military R&D (Reppy 2000). The US Dept. of Defence fund, through the Small Business Innovation Research Programme (SBIR) and the Small Business Technology Transfer Programme (SBTT), over $1 billion each year in early stage R&D projects in small technology companies aimed at servicing the needs of the defence industry.

Accepting the challenge of the Innovation Task Force for the need for an ambitious game changer to secure Ireland’s economic future, the SmartOcean Strategy Working Group poses the question to our Entrepreneurs, SMEs, Multinationals, Industry bodies, Academia, State Agencies, Government, Venture Capital, Media and Public, to consider the following question.

*Can Ireland address major global challenges and emerging market opportunities by utilising our unique Ocean Resource as a catalyst for innovation building on our existing Knowledge Economy Clusters?*

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5 www.infomar.ie
6 Reppy 2000
7 Innovation Ireland, page 10
3 Capturing Market Opportunities

3.1 Introduction

While defence has been a key driver historically of ocean technologies, the world as we know it has changed dramatically. In living memory the world population has expanded from 3 billion to 6.7 billion and is expected to reach 9 billion in 2050.8

The world’s economy, in terms of global gross domestic product (GDP), has grown at an unprecedented rate: €4 trillion in 1950 to €42 trillion in 2007. In contrast to this economic growth, our global environment has suffered considerably. Our energy needs have depleted global resources and simultaneously have stressed climate and our environment. Our food needs, particularly those of the ocean, are been stretched to fragile limits and our water, the most basic supporting component of life is no longer in balance. Sustainability - is now a global challenge. Recognition is finally dawning that our natural world is no longer a backdrop to our society, but the bedrock of our very existence.

Renewable Energy, Water, Environmental Monitoring & Management are now among the key challenges facing the world. Each of these challenges is in fact an opportunity and is opening markets for innovative and knowledge enabled solutions.

Equally the established market for carbon-based energy, fish & aquaculture, shipping & ocean transport & logistics, and coastal tourism can also benefit from innovative technologies derived from the emerging market challenges.

Figure 3: Established and Emerging Ocean Technology Markets

8 EEA Signals 2009 - Key Environmental Issues Facing Europe
The integration of enabling technology platforms and the convergence of ICT and marine related sectors represents a significant opportunity for Ireland. Current and emerging marine related sectors (e.g. transport, security and logistics, offshore energy aquaculture and environmental monitoring) face similar technology challenges. These include the deployment of distributed sensor networks (e.g. on ships, offshore platforms, networked databuoys etc), the development of suitable software and control interfaces, access to communication links for data transfer (satellite, cable, wireless) and data management, visualisation and forecast capabilities. Opportunities exist for the development of a suite of intelligent decision-based management tools to address the needs of these sectors.

For established markets, such as transport, security and aquaculture early win opportunities could involve interfacing commercially available sensor technologies to communication networks. Significant opportunities exist for this approach in the area of environmental monitoring (as recently demonstrated by the MI-EPA funded DEPLOY project).

Key drivers for emerging markets include current and impending legislation requirements such as the EU Water Framework Directive, EU Marine Strategy Framework Directive; EU Floods Directive and the need for Strategic Environmental Assessments (SEA) and Environmental Impact Assessments (EIA). The integration of technology platforms offers the opportunity to implement cost effective monitoring programmes in support of policy implementation needs.

Additional market drivers include the need to maintain security of supply in the areas of energy and water; efficient resource management (e.g. aquaculture, catchment management and land use) and the sustainable economic development of natural resources in coastal and freshwater environments.
### Table 1: Established Markets and Some Relevant Technology Applications

<table>
<thead>
<tr>
<th>Targeted Markets</th>
<th>Technology Applications</th>
<th>Potential Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oil &amp; Gas</strong></td>
<td>- Hind cast and predictive weather modelling for offshore operations.</td>
<td>- Oil and Gas companies</td>
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<td></td>
<td>- Data management and visualisation</td>
<td>- Regulatory Authorities</td>
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<tr>
<td></td>
<td>- Data transmission</td>
<td>- Service companies supplying offshore installations</td>
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<td></td>
<td>- Monitoring resource extraction and estimation of remaining supply</td>
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<td></td>
<td>- Environmental status monitoring</td>
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<td></td>
<td>- Environmental Impact Assessment</td>
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<tr>
<td><strong>Aquaculture and Fisheries</strong></td>
<td>- Fish habitat monitoring</td>
<td>- Fishermen and Co-Operatives</td>
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<td></td>
<td>- Sustainable Fisheries resource management</td>
<td>- Regulatory bodies</td>
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<td></td>
<td>- Acoustic based fish detection</td>
<td>- Fish stock managers</td>
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<td>- Harmful algal bloom monitoring and mitigation</td>
<td>- Finfish and shellfish farm operators</td>
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<td></td>
<td>- Stock loss mitigation</td>
<td>- Quality controllers</td>
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<tr>
<td><strong>Maritime Transport/Security/Logistics</strong></td>
<td>- Fleet Management</td>
<td>- Shipping Companies and their customers</td>
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<td></td>
<td>- Asset tracking</td>
<td>- Port Authorities</td>
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<td>- Surveillance monitoring</td>
<td>- Customs</td>
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<td>- Safety at Sea</td>
<td>- Coastguard</td>
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<td>- Ship control systems and data management</td>
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<td>- Simulation and training tools</td>
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<td></td>
<td>- Underwater communications</td>
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<tr>
<td><strong>Coastal Tourism</strong></td>
<td>- Weather forecasting,</td>
<td>- Tourism Operators</td>
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<td></td>
<td>- Water Quality monitoring</td>
<td>- Local Authorities</td>
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<tr>
<td></td>
<td>- Safety at Sea</td>
<td>- General Public</td>
</tr>
</tbody>
</table>

*Established Markets*
### Table 2: Emerging Markets and Some Relevant Technology Applications

<table>
<thead>
<tr>
<th>Targeted Markets</th>
<th>Technology Applications</th>
<th>Potential Customers</th>
</tr>
</thead>
</table>
| **Environment / Water** | - Environmental Monitoring Based on Emerging Wireless Technologies  
- Coastal Zone management  
- Enabling of time series environmental monitoring data in remote locations  
- Power management: Efficient long term autonomous deployments of Sensor Networks  
- Acoustic based fish/marine mammal detection. Tracking environmental status  
- Monitoring security and safety of water supply | - Oil and Gas Companies  
- Ocean Energy Operators  
- Local Authorities  
- Regulatory Authorities  
- Shipping Companies  
- Water Companies |
| **Marine Renewable Energy** | - Data collection, transmission and visualisation from marine renewable installations  
- Integration of devices into communications network for data retrieval  
- Supply of real time information on changing weather and sea conditions  
- Remote acoustic monitoring of protected species listed under Habitats Directives  
- Biofouling Mitigation through integration of novel materials, chemistry and physical architectures | - Marine renewables device developers  
- Utility Companies  
- Regulatory Authorities |

3.2 Market Insights

The following is not intended to be an in-depth market analysis. Our experience from involvement with entrepreneurs, SMEs and Multinationals is that they themselves have proved to be the best judges of the ideal target niches once they have engaged with the emerging SmartOcean Innovation Cluster. However the following section gives an indication of some of the emerging market opportunities.
3.2.1 Renewable Energy

As an island set in the Atlantic Ocean, Ireland has the highest wave energy resource in Europe, with an estimate generating capacity of 60GW (1/5 of Europe’s resource)\(^9\).

While Ocean Wave Energy is at an early stage of development, Tidal Energy, also at early development stage, is now moving to commercial scale with projects like:

- SeaGen Tidal Systems in Strangford Lough in Northern Ireland;
- Irish company Open Hydro who signed a €1.7 million steel fabrication contract with Cherubini Metal to support the first Canadian tidal turbine deployment. In March 2010, OpenHydro was also awarded the rights to develop a 200 – megawatt tidal wind farm off the north coast of Scotland.

Wind Energy, already firmly established on shore, is now moving off-shore and the UK already sees itself as the world leader in this domain and has awarded 32GW of offshore wind licences to-date. Ireland has equally impressive off-shore wind resources and has the opportunity to grow with this emerging global industry.


Global, and particularly European, activity in the development and deployment of marine renewable energy technologies (offshore wind, wave and tidal) is accelerating rapidly. Projections by the European Wind Energy Association point to rapid growth in deployment of offshore wind in Europe. While wave and tidal technology is at an earlier stage of development, current plans for deployment in Europe, indicate that this sector will expand rapidly in the coming decades.

**Statistics**

- **Wave and Tidal Global Market**
  In 2007/2008, the estimated global wave and tidal market was worth £1.98 billion sterling\(^10\). According to the World Energy Council, a non-profit research organisation, the potential market for wave energy is worth about $1 trillion worldwide\(^11\).
- **Offshore Wind Expenditure**
  The total global CAPEX for offshore wind in 2009 was an estimated $2.033bn with a projected annual average growth rate of 34.72% over the period 2009-2014\(^12\).
- **Advanced Materials and Devices for Renewable Energy Systems Market**
  The total global market for advanced materials and devices for renewable energy systems (marine and non-marine) was worth almost $2.4 billion by the end of 2006\(^13\). Growing at a Compound Annual Growth Rate (CAGR) of 25.8%, the market is estimated to be worth almost $7.5 billion by 2011. Ocean energy had the highest growth rate through the forecast period, reaching $360 million in 2011, a CAGR of 66.5%.

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\(^9\) IDA Ireland Ocean Energy in Ireland.
\(^10\) Tidal Today 2009 Global Wave and Tidal Market
\(^11\) AltProfits 2009 Wave and Tidal Energy Valuation
\(^12\) Douglas Westwood Ltd.
\(^13\) BCC Research 2007 Advanced Materials and Devices for Renewable Energy Systems
The significant potential for Ireland, in harnessing its marine renewable energy resources, is to become an exporter of electricity to Europe, to assist in the decarbonisation of power generation and the transformation of the economy from fossil fuels to electricity. Indicative figures of the value to Ireland, from the production and export of just 2GW of electricity are:

- Electricity generated per annum: 6 Twhr
- Annual Revenue: €1.0 bn
- Permanent Jobs (O&M): 3,000
- Construction jobs: 10,000
- Supply Chain (max): 20,000

The emerging vision for the sector is that development of the marine renewable sector will continue to grow to at least 2050, where 50GW of installed capacity will provide some 1.5-2% of the EU electricity market, offering economic potential of the following order of magnitude:

- Electricity exported: 155 TWh
- “Near” Market Share: 2-3%
- Annual export earnings: €10-20 bn
- Permanent Jobs (O&M): 75,000

Source: SEAI

### 3.2.2 Environment & Water

Water management, climate change and renewable energy development are some of the key global issues facing the planet over the next generation. Real-time monitoring of water quality, storm surges and coastal flooding is becoming more common in the interest of public safety. With the growing awareness of climate change attention is now turning to the development of solutions to mitigate the threat of natural water-related disasters and improve the management of water as a valuable resource. Globally, water security, availability and quality are rapidly becoming a vital and scarce resource. Water availability is under pressure from an ever-increasing consumer demand (e.g. industry, farming, domestic) while water quality is being impacted by pollution and other environmental pressures. This has resulted in the need and demand for new and innovative water monitoring technologies, wastewater treatments and recycling technologies.

Opportunities exist for indigenous Irish companies to work with research teams to develop and roll out niche sensing and communications technologies capable of remote sampling and analysis over extended periods, essentially developing the building blocks of an environmental nervous system comprised of many distributed sensing devices that share their data in real time over the web.
Markets Snapshot: Irish Environmental Goods and Services Sector

Statistics
- Environmental goods and services sector valued at €2.8 billion in 2008
- Directly employs more than 6,500 people

EGS sub-sector consists of:
- Water/ Wastewater treatment valued at €1 billion
- Waste management valued at €550 million
- Environmental Services/ Clean Tech valued at €560 million
- Note: Renewable energies sub-sector in this report valued at €700 million

Source: Intertrade Ireland/ Forfás Environmental Goods and Services Sector Report 2008

Markets Snapshot: Water

- Water and Wastewater Applications Expenditure
  The expenditures for water and wastewater applications were $11,290 million in 2007. They are expected to grow at a CAGR of 22.2% and reach $39,709 million by 2012.

- Infrastructure Application Market
  The infrastructure application market is expected to grow at a CAGR of 22.6% to reach $32,041 million by 2012.

- Industrial Water and Wastewater Equipment Market
  The industrial water and wastewater equipment market is expected to grow at a CAGR of 14.2% to reach $10,111 million by 2012.

Source: BCC Research 2007 Growing Markets for Water and Wastewater Technologies
Markets Snapshot: Water Technologies

- **Environmental Sensing and Monitoring Technologies**
  According to BCC Research, the global market for environmental sensing and monitoring technologies was worth $9.1 billion in 2008 and an estimated $10.1 billion in 2009. This should reach $13 billion in 2014, for a compound annual growth rate (CAGR) of 5.2%.

  Radon and remote sensing and new technologies have the largest share of the market, generating $4.9 billion in 2008 and an estimated $5.1 billion on 2009. This segment is expected to be worth $6.8 billion in 2014.

  Terrestrial sensing and material technologies combine for the second-largest market share, generating 2.6 billion in 2008 and an estimated 2.7 billion in 2009. This is expected to grow at a CAGR of 4.7% to reach 3.4 billion in 2014.

  Source: BCC Research 2009 Environmental Sensing and Monitoring Technologies: Global Markets

- **Forecasting and Remote Sensing Technologies**
  A report by BCC Research in 2007 estimated that the global market expenditures for remote sensing products were more than $7 billion in 2006 and should reach almost $7.3 billion in 2007. This market is expected to reach more than $9.9 billion by 2012.

  Weather forecasting holds the highest share in this market throughout this period accounting for approximately 38% of the total market share through to 2012. Climate change studies expenditure is expected to amount to over $750 million by 2012, an increase from the $500 million spent in 2007.

  Source: BCC Research 2007 Remote Sensing Technologies and Global Markets

Frost and Sullivan research shows the market for water management and monitoring systems is close to a US$2 billion dollar industry; within which marine monitoring applications served by integrated and real-time systems represent around 10%.

The study showed that within this small segment of the market, promising global market opportunities exist in Energy, Oil and Gas, Aquaculture and Ports & Harbours. The following provides a snapshot of some of the findings:

- Traditionally, the Oil & Gas sector has been the largest consumer of RTIMS and it represented a share of almost 40% of the total market in 2007. Greenfield opportunities in Asia Pacific, Middle East, and Latin America, together with the move to drill at deeper levels and in harsher environments should continue to drive growth over the forecast period.

- Growth in the Ports & Harbour sector is expected to be affected by a fall in international trade and its impact on container traffic in the short-term. However, Ports & Harbours should still provide considerable growth opportunities particularly in Asia-Pacific in the medium to long-term.

- The Aquaculture sector will continue to benefit form the gradual move towards sustainable production of fish and seafood, with revenues expected to reach US$37 million by 2015.

- Although the market for Marine Energy was only estimated at US$1.5 million in 2007, it is expected to present the most significant growth opportunity in percentage terms over the forecast period.

Source: Frost and Sullivan 2009
Markets Snapshot: Aquaculture and Real-Time Environmental Monitoring

In 2006, global production in the aquaculture sector was estimated to be 51.7 million tonnes with a value of US$78.8 billion representing an annual growth rate of nearly 7 per cent\textsuperscript{14}.

Real time monitoring of the marine environment surrounding food production area, as in shellfish and finfish aquaculture in open water, offers scope to enhance product traceability and assure product quality and can be enabled by novel sensing systems linked into communications networks. Remote sensing using satellites and airborne systems is well established and combined with oceanographic modelling capabilities will enhance our ability to identify and respond to algal, and more recently jellyfish, blooms that can sometimes threaten the aquaculture, tourism and fisheries.

Markets Snapshot: Other Opportunities

There are, no doubt, many other SmartOcean Technology opportunities, not addressed in this Consultation Document. These might include, for example:

- Application of nano-technologies: nano-bots and ANTS (autonomous nano-technology systems);
- Carbon Capture and Storage, including deep-sea burial;
- Satellite and Aerial Remote Sensing;
- Smart Materials – new composite materials based on nano-architectures modeled on skeletal structures of marine organisms and providing improved mass to strength ratios, anti-fouling surfaces and greater longevity in salt waters;
- Vessel Traffic Management and Surveillance Monitoring Systems, including trans-Arctic shipping trade routes.

It is anticipated that these and other opportunities will be identified and developed during the consultation phase and further elaborated and developed in the final Strategy Document.

\textsuperscript{14} FAO: The State of World Fisheries and Aquaculture 2008
4 Capturing Existing Strengths

4.1 Introduction
Ireland has considerable strengths which could be harnessed to create a vibrant SmartOcean Innovation cluster focused on niche and specialist ocean technologies. This section outlines relevant investments in science and technology, research strengths in academic institutions and public agencies, and the strength of our existing ICT cluster and emerging ocean cluster.

4.2 Investment in Science and Technology
Since 2000, S&T policy in Ireland has placed increasing emphasis on research and development:
- Science Foundation Ireland (SFI), established in 2003, is funding scientists and engineers working at the frontiers of biotechnology, information and communications technology and, more recently, sustainable energy and energy-efficient technologies.
- The Higher Education Authority (HEA) Programme for Research in Third Level Institutions (PRTLI) investments have been strengthened and aligned to support critical infrastructure provision and the development of human capital.
- The IDA has reinforced its drive to attract R&D activities to both upgrade existing FDI client operations in Ireland and to seed new activity.
- Enterprise Ireland has increased its focus on driving indigenous company innovation and commercialisation from increased R&D activity in the HEIs.
- The EPA Environment R&D programme (STRIVE) is generating knowledge and expertise needed to protect and manage Ireland's environment, with an increasing focus on technology-driven solutions and cleaner, greener production methods.
- The Marine Institute R&D programme in addition to funding research aimed at developing Ireland's marine sector (e.g. fisheries, aquaculture and seaweed) and protecting the marine environment, provides support for multi-disciplinary research programmes in areas with high growth potential, e.g. marine technology (sensors & communications) and biotechnology (including functional foods).

This investment is beginning to have a significant impact. Total Irish R&D spending has almost trebled to €2.6 billion in 2008, which is equivalent to 1.66% of Gross National Product (GNP). A strong commitment to continue to deliver on the investment framework set out in Strategy for Science Technology and Innovation and implemented via the NDP 2007-2013 is contained in the report of the Innovation Task Force (2010).
Sea Change - A Marine Knowledge, Research & Innovation Strategy for Ireland 2007-2013, which is marine component of the SSTI strategy, was approved by government in 2007. The aims and objectives of the Sea Change Strategy are to contribute to the knowledge economy, to the achievement of key national strategic objectives (Competitiveness and Growth, Innovation, Regional and North-South Development, Environmental Sustainability) and to enhance Ireland’s profile as an international leader in marine research and innovation.

Significant investments over the last ten years have had a transformative effect on the Irish marine research landscape, providing new and significant research capacity, capabilities and infrastructures. Over the period 2000-2006 an estimated €268m was invested in marine RTDI (via a combination of core exchequer, NDP and international funds). An estimated 500 researchers were actively involved in marine research in 2005. In the first three years of Sea Change (2007-2009), an estimated €107m of R&D funds have been committed to marine research from national and international funding sources (which includes a ~€50m committed under the NDP Marine Research Sub-Programme). Since the launch of Sea Change, new funding (national and international) has created new research positions and capacity. An estimated 170 new research positions (PIs and Post-Docs) and 176 new PhD scholarships were created since 2007.

4.3 Research Strengths in Public Research Institutions

These investments (marine and non-marine) have resulted in the development of key research centres with strong capacity in the areas of advanced materials and sensing; communications and informatics, marine and environmental science.
<table>
<thead>
<tr>
<th>Centres</th>
<th>Description</th>
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<tbody>
<tr>
<td>National Centre for Sensor Research (NCSR), Dublin City University</td>
<td>The NCSR is a globally recognised centre of excellence in sensor related research. The centre was initially funded by PRTLI Cycle I and now comprises 260 researchers focused on sensor development. The centre hosts the Marine Institute-funded Beaufort Research Team, focused on the development of novel sensing and communications systems for the Marine Environment. The NCSR also hosts a Chair of Marine and Environmental Sensing. The development of environmental monitoring systems is strategic research priority and the NSCR has a strategic partnership with the QUESTOR Centre (Queens University Belfast) on emerging environmental technologies. In addition, the NCSR houses related SFI funded Centres of Excellence in Separation Science and Biomedical Diagnostics.</td>
</tr>
<tr>
<td>Tyndall National Institute (TNI) University College Cork, Cork Institute of Technology</td>
<td>Tyndall National Institute is focal point for Information and Communications Technology (ICT) in Ireland and supports industry and academia nationally. The Centre comprises over 300 researchers focused on the areas of photonics, electronics, materials and nanotechnologies. Applications include the areas of environmental monitoring, medical devices and life sciences, communications, power electronics and other industries. The capabilities of the central fabrication facility range from theoretical modelling and design through to novel device processing, fabrication, packaging and systems integration.</td>
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<tr>
<td>Integrated NanoScience Platform for Ireland (INSPIRE) Trinity College Dublin, University of Limerick, University College Cork, Dublin Institute of Technology, Dublin City University, NUI Galway, Cork Institute of Technology, University College, Dublin</td>
<td>INSPIRE is Ireland’s platform for research in nanoscience, including nanoelectronics, nanophotonics and bionanoscience, funded by the HEA PRTLI Cycle 4. The three key research domains in INSPIRE are: Nanoelectronics, Nanophotonics and Bionanoscience supported by a fundamental cross-cutting research in Nanomaterials Synthesis and Characterisation. Research outputs will impact fields such as telecommunications, data storage, optical sensing and imaging, and medical devices, all of which have been revolutionised by photonic technologies.</td>
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<tr>
<td>LightHouse NUI Galway</td>
<td>LightHOUSE: Centre for Applied Photonics, conducts research and technology development in the areas of Laser microfabrication; Photonics-based Nanotechnology; Smart optics Imaging; Optical characterisation. The centre is a research partnership which combines the expertise of the National Centre for Laser Applications (NCLA) and the Applied Optics Group, into a centre of excellence in applied photonics with regional and national impact and importance on the international research stage.</td>
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<td>Centres</td>
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<td><strong>CLARITY</strong>&lt;br&gt;University College Dublin&lt;br&gt;Dublin City University&lt;br&gt;Tyndall National Institute&lt;br&gt;<a href="http://www.clarity-centre.org/">http://www.clarity-centre.org/</a></td>
<td>CLARITY is an SFI funded centre for sensor web technologies. The focus of the research centre includes harnessing large volumes of sensed information, from both physical and digital domains. CLARITY focuses on the intersection between Adaptive Sensing and Information Discovery. Research outputs contribute to improving the quality of life of people in areas such as personal health, digital media and management of our environment. Distributed environmental sensing is one of the prioritised areas of research. Industry partners include IBM and Episensor.</td>
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<td><strong>Telecommunications Software &amp; Systems Group (TSSG), Waterford Institute of Technology</strong>&lt;br&gt;<a href="http://www.tssg.org/">http://www.tssg.org/</a></td>
<td>The TSSG comprises over 150 research active staff and students focused on communications software services. This includes emerging architectures for management of complex telecommunications and Internet systems and next generation service development and deployment. The TSSG has strong expertise in the areas of distributed systems and service oriented architectures for the communications and telecommunications domain. The centre is co-located with business training and business incubation facilities.</td>
</tr>
<tr>
<td><strong>Institute of Microelectronics and Wireless Systems (IMWS), National University of Ireland, Maynooth</strong>&lt;br&gt;<a href="http://www.imws.nuim.ie/">http://www.imws.nuim.ie/</a></td>
<td>The IMWS is a multi-disciplinary research group that brings together domain experts in a number of complementary areas to address the challenging cross-domain system level issues for wireless systems. Specific research themes include; Audio Signal Processing for Wireless Systems, Wireless Sensor Networks, and Mobile and Wireless Services and Applications.</td>
</tr>
<tr>
<td><strong>Centre Telecommunications and Value Chain Research (CTVR), Trinity College Dublin, NUI Maynooth, Tyndall National Institute, University College Cork, University of Limerick, Dublin Institute of Technology, Dublin City University</strong>&lt;br&gt;<a href="http://www.ctvr.ie/">http://www.ctvr.ie/</a></td>
<td>The Centre for Telecommunications Value-Chain Research (CTVR) brings together a multi-disciplinary group of academic and industrial researchers to work on engineering and scientific challenges for the telecommunications networks of the future. Initial funding for the centre was provided by Science Foundation Ireland and IDA Ireland. Specific research themes include the development of next generation telecommunications systems, architectures and networks. The Centre’s principal industrial partner is Bell Labs.</td>
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### Centres

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<td>STRATAG leads a research programme in the area of Advanced Geotechnologies. Research is focused around the generic theme of Geospatial Monitoring and Early Warning Systems through investigations on Sensor Integration; Spatial Algorithms; Visualisation and Location Based Services. Sensor technologies of interest include integrated laser scanning and remote imaging in airborne and terrestrial systems. Positioning technologies of interest include GPS and inertial systems in airborne, terrestrial and marine environments. The STRATAG team address challenges related to the processing of collected sensor data and its integration with positioning and imaging information to provide geospatial monitoring solutions.</td>
<td>Strategic Research in Advanced Geocomputation (STRATAG), NUI Maynooth, University College Dublin, Trinity College Dublin Dublin Institute of Technology <a href="http://www.stratag.ie/">http://www.stratag.ie/</a></td>
</tr>
<tr>
<td>DERI is a Centre for Science, Engineering and Technology (CSET) established in 2003 with funding from the Science Foundation Ireland. The centre is defining and executing a research agenda targeted at enabling and supporting people, organisations, and systems to collaborate and interoperate on a global scale using semantic web technologies. DERI collaborates with academic and industrial partners such as CISCO, Ericsson, Storm, HP and IBM.</td>
<td>The Digital Enterprise Research Institute (DERI), NUI Galway <a href="http://www.deri.ie/">http://www.deri.ie/</a></td>
</tr>
<tr>
<td>LERO was established with support from Science Foundation Ireland. It is a collaborative organisation, embracing the software engineering research activities of the academic research partners. LERO develops models, methods and tools that make it cheaper, faster or easier to produce software for specific domains where reliability is crucial, including automotive, medical devices, telecommunications and financial services.</td>
<td>Irish Software Engineering Research Centre (LERO), University of Limerick Dublin City University Trinity College Dublin University College Dublin <a href="http://www.lero.ie/">http://www.lero.ie/</a></td>
</tr>
<tr>
<td>The UCD CASL comprises 30 PIs and over 170 Postgraduates and Post Doctorates from a variety of UCD schools including Business, Computer Science and Informatics, Engineering and Geological, Mathematical and Medical Sciences. Expertise in applied mathematics and computational science, is used to identify similar problems and tools across distinct disciplines. Thematic Clusters include Computational Biology, Computational Science, Data Intensive Science, Sensing Systems, Mathematics of Information &amp; Communication, and Mathematical Finance. CASL’s Innovation Research Unit (IRU) investigates the governance of complex innovation systems on the international, national, regional and sectoral level.</td>
<td>Complex and Adaptive Systems Laboratory (CASL), University College Dublin <a href="http://casl.ucd.ie/">http://casl.ucd.ie/</a></td>
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<tr>
<td>Centres</td>
<td>Description</td>
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<tr>
<td>Martin Ryan Marine Science Institute (MRI), NUI Galway</td>
<td>The Martin Ryan Institute is a regional, national and international Centre of Excellence for the study of marine and freshwater resources. Research themes include Biodiscovery, aquaculture, climate and environmental change, marine microbiology and physical and chemical oceanography. The Institute was funded from a number of sources including private donations; structural funds from the EU STRIDE programme, the PRTLI programme Cycle 3. The MRI has developed active links and programmes of cooperation with Industry, with State and Regional development Agencies including the Marine Institute.</td>
</tr>
<tr>
<td>Hydraulics and Maritime research Institute (HMRC), University College Cork</td>
<td>The HMRC was established in 1979. It is a centre of excellence within Ireland for Ocean Renewables and Coastal Engineering providing support to the maritime industry as well as fundamental R&amp;D. The HMRC is staffed by a range of engineers; including civil, environmental, electrical and electronic, mechanical, aeronautical and oceanographic providing a diverse assortment of experience and skills to explore multi disciplinary technology. The Centre houses the only facilities for wave simulation in Ireland with a Wave Flume and an Ocean Wave Basin.</td>
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<tr>
<td>Coastal and Marine Resources Centre (CMRC), University College Cork</td>
<td>The primary objective of the CMRC is to make a significant contribution to the scientific understanding of coastal and marine environments and their management. The CMRC is based in the Lewis Glucksman Marine Facility, University College Cork, which is located at the Irish Naval Base, Haulbowline. A significant objective of the Centre’s strategy 2009-2014 is to contribute to the development of Ireland’s ocean energy sector by providing a diverse range of expertise to underpin the marine spatial planning process. This is achieved through CMRC participation in the Maritime and Energy Cluster (MERC-Ireland). CMRC research focuses on Coastal Processes &amp; Seabed Mapping; Marine Geomatics; Marine Ecology Group and Coastal Governance.</td>
</tr>
<tr>
<td>Mobile and Marine Robotics Research Centre (MRRC), University of Limerick</td>
<td>The MRRC is focused on the development of remote vehicle and payload technologies for subsea commercial and scientific applications. Research includes the development of submersible autonomous robots, unmanned underwater vehicles and associated control systems. Key enabling technologies include, artificial intelligence, sonar and vision systems. Simulation software capabilities are applied to training and survey planning. The development and integration of remotes sensors for environmental sensing is also a research area of interest.</td>
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## Centres

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<tr>
<td>ICARUS are focused on understanding of climate change and its impacts, with particular emphasis on Ireland, analysis of past climate trends and their causes, regional climate modelling and assessing impacts for the future. ICARUS is one of the largest dedicated climate change research and modelling centres in Ireland conducting both pure and applied research, covering all aspects of climate change from regional climate modelling to impact assessments on a variety of sectors and provides a wide and diverse range of research capabilities in the climatic arena. ICARUS is part of the Department of Geography, NUIM, and builds on over 35 years of climate change research conducted within the department.</td>
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<tr>
<td>The Environmental Research Institute (ERI) was established in 2000 through the Higher Education Authority (HEA) Programme for Research in Third Level Institutions Cycle 2 (2000-2003). The Institute brings together over 150 researchers with expertise in the biological, chemical and environmental sciences as well as environmental engineering, energy and environmental law (from 11 cognate departments and four centres of excellence thereby facilitating a critical collaborative approach to a subject area across many disciplines. Research activities at the Institute are strategically focused on five thematic research areas including Sustainable Energy/Environmental Engineering; Marine and Freshwater Environments and Environmental Law.</td>
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<tr>
<td>The MI is a public agency with over 200 technical, scientific and administrative staff. Facilities include 54 laboratories headquartered in Oranmore, Co. Galway, Aquaculture and Catchment Management research Facility in Newport Co. Mayo and a range of specialised research infrastructure including two national research vessels. Research strengths include programmes in the area of fisheries, aquaculture, food safety and deep sea research. The institute also conducts research in the areas of climate change and ocean mapping.</td>
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### Marine & Environment

<table>
<thead>
<tr>
<th>Irish Climate Analysis and Research Units (ICARUS), NUI Maynooth</th>
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<tr>
<td><a href="http://icarus.nuim.ie/">http://icarus.nuim.ie/</a></td>
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<table>
<thead>
<tr>
<th>Environmental Research Unit (ERI), University College Cork</th>
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<tr>
<td><a href="http://www.ucc.ie/en/eri/about/">http://www.ucc.ie/en/eri/about/</a></td>
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<tr>
<th>Marine Institute (MI), Galway, Newport Co. Mayo, Dublin</th>
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<td><a href="http://www.marine.ie/Home/">http://www.marine.ie/Home/</a></td>
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4.4 Industry Capacity and Entrepreneurship

The importance of the ICT sector to the Irish economy is significant. Ireland boasts major European investments for Intel, Hewlett-Packard, Alcatel-Lucent, IBM, Microsoft, Oracle, Ericsson, Analog Devices, and Xilinx. Google is a recent arrival, Dell is a recent loss. Equally Ireland has continued to develop its indigenous ICT sector with IONA Technologies (now Progress), Parthus (now CEVA), Trintech, AEP Networks, Havok (Intel), Cape Clear (now Workday), Norkom, Corvil Networks, Automsoft, Intune Networks, Valista, Newbay, S3 and many more.

In total, the Irish ICT Sector comprises over 1300 companies employing over 87,000 people and generating sales of Euro 75 Billion with 51% turnover generated in manufacturing and 49% generated in ICT services.

<table>
<thead>
<tr>
<th>ICT Sub-Sectors</th>
<th>Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware &amp; Systems</td>
<td>317</td>
</tr>
<tr>
<td>Application Software</td>
<td>527</td>
</tr>
<tr>
<td>Support Services</td>
<td>47</td>
</tr>
<tr>
<td>Microelectronics Design</td>
<td>24</td>
</tr>
<tr>
<td>Digital Content</td>
<td>120</td>
</tr>
<tr>
<td>eBusiness</td>
<td>155</td>
</tr>
<tr>
<td>Enterprise Application Integration Software</td>
<td>12</td>
</tr>
<tr>
<td>IT Services</td>
<td>45</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1317</strong></td>
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</table>

The majority of the employees by sector are in the Hardware & Systems sub-sector which has over 28,000 employees and the second largest sub-sector is Application Software with over 527 companies.

All sub-sectors have over 85% of their sales in export except for IT services and Telecommunications. Even IT Services, which has a slightly higher local market, is still over 70% in export. The only true local market is for telecommunications with only 13% in export sales.

While foreign-owned companies have contributed significantly to the ICT sector (70% of the employment), indigenous companies have developed within the cluster and dominate the Enterprise Application Integration and eBusiness sub-sectors and are growing towards parity on the Digital Media.

Ireland has largely weathered the global downturn in ICT very well, but as the global ICT sector continues to evolve, Ireland is responding with focused actions in R&D, new product development and global supply chain management. The importance of the indigenous ICT sectors has become ever more evident. But Ireland, as all European countries, faces unprecedented challenges to continue to grow knowledge intensive industries and investment in the face of growing and unremitting competition from China, India, Brazil and South East Asia as well as the new entrant Eastern European economies. Asia is in the
ascendancy and its growing domestic demand suggests a resiliency beyond the historic positioning of low-cost supplier to the West.

Irish employment has continued to grow significantly over the last decade, but is now in a steep drop with traditional manufacturing sectors experiencing job decreases and continual pressure even in the more knowledge intensive sectors ICT and Life Science sectors.

In response to this, Ireland has both deepened and adapted its enterprise strategy model to face these challenges by squarely focusing on its core strengths and on high value niche areas to sustain levels of competitive performance in line with the world’s best. The entrepreneur is now moving towards a central role, SMEs are clearly crucial to Ireland’s future and Ireland must maintain its attractiveness to the best-in-class international companies located here and locating here.

There has been a strong upward trend in R&D performance and Ireland continues to invest heavily across the full spectrum from basic research to advanced development with nearly €2.6B of annual gross expenditure on R&D by all industry, education and government. While Ireland has been exceptionally strong in world-class operations, Ireland’s enterprise strategy is focused on deepening and specialising its R&D intensity while simultaneously developing and expanding international sales and marketing expertise to complement the operational skill base.

Complementing Industry investment in R&D, State support has been significant through SFI on research, PRTLI on research infrastructure and direct support through semi-state agencies such as EPA on environment and Marine Institute in marine.

Given Ireland’s strong ICT cluster, its serial entrepreneur base, and its international reach, the opportunity is now to harness Ireland’s Ocean Technology Cluster as an innovation test-bed to deliver new solutions to new markets.

Concrete activities are already under way and the following snapshots illustrate some of the companies that are emerging as potential participants in SmartOcean cluster.
**Nowcasting Weather: A world-leader in marine forecasting**

Nowcasting is a leading Weather Forecasting company, supporting offshore operators with their meteorological and oceanographic forecasting needs. The company, headquartered in Ennis, Co. Clare employing 16 people, currently has operations in the North Sea, Gulf of Mexico, the Mediterranean, West Africa, South America, Asia and Sakhalin Island and has been working in the offshore oil and gas industry for over 10 years. The core technology capabilities and expertise is focused on the provision of high resolution weather datasets generated by specialised computer models. The information provided allows offshore operators to efficiently and safely manage their weather downtime resulting in significant cost savings and improving safety.

**MCS Kenny: Delivering effective sub-sea solutions**

MCS Kenny (formerly MCS) is a global subsea engineering consultancy which provides a range of specialist design, analysis, engineering software and technology services to clients in the offshore oil and gas industry. MCS Kenny is headquartered in Galway and has a staff of over 200 in six locations around the world, namely Galway, Aberdeen, Houston, Perth, Paris and Rio de Janeiro. MCS Kenny is a subsidiary of Wood Group plc, which is an international oil and gas services company. MCS Kenny directly and through sister companies in Wood Group provide a comprehensive range of services to the renewable energy and carbon capture markets.

**InTune Networks: Developers of exploration and production monitoring technologies for reservoir profiling**

Intune Networks is one of Europe’s largest Telecommunications optical engineering design and development companies which was established in 1999 and has invested over €45 million developing telecoms and sensor solutions using electronically controlled tunable laser systems. Intune is about to spin-out a company to partner with geoscience firms and major oil and gas services firm to deploy its Life of Field Seismic reservoir profiling solutions. The spin-out company will build on Intune’s platforms to apply the technology into the next generation of 4D Seismic exploration solutions. These solutions will deliver a highly disruptive ultra accurate optical seismic sensor exploration measurement system that will enable and transform proved, probable and possible reservoir assessment. It will also simultaneously optimise production planning for offshore and on-shore reservoirs.

**Wireless Fibre Systems Ltd: Making waves with its subsea Radio Frequency Broadband Communication System**

WFS is a leading developer of through-water and through-ground electromagnetic communications and sensing products. With over 90 patent applications filed in Europe and North America, their revolutionary products deliver cost savings and new capabilities to the Oil & Gas, Environmental & Industrial, and Defence industries. Wireless Fibre Systems Ltd is based in Livingstone Scotland and provides customised wireless broadband and optical network products for commercial, industrial and homeland security application. Their clients include the defence sector and oil and gas producers.
**TechWorks Marine: Providing world-class marine and environmental solutions**
TechWorks Marine provides clients with world-class marine environmental monitoring solutions as well as real-time data from their own monitoring platforms. This real-time data enables their clients to make effective management decisions. TechWorks Marine solutions are based on their own proprietary data acquisition and transmission system. The company was founded in 2001 in response to a demand for integrated environmental monitoring platforms for the marine industry.

**Cathx Ocean: Specialising in engineering and innovation in underwater lighting**
Cathx Ocean specialise in innovation and engineering of lighting, lasers and robotic vision systems for divers and underwater vehicles. Their products are designed to operate in the harshest ocean conditions and at extreme depths as far as 5000 metres below the surface. The company was founded in July 2009 and are based in Rathangan Co. Kildare and currently employ 5 people. The Euphos range of products was released to market in the UK and US in October 2009 and targets search and rescue divers, underwater lighting for television and video imaging and rugged lighting for commercial working divers.

**Biospheric Engineering Ltd: Leading environmental acoustic service providers**
Established in 1999, Biospheric Engineering Ltd has developed an underwater noise capability including calibration to international standards. Biospheric are experts in acoustic monitoring and have developed innovative and accurate monitoring solutions for a wide range of infrastructure projects. The company has strong capabilities in environmental impact studies, measurement of background noise levels, equipment for salinity, temperature sound and speed profiles. Biospheric is currently working with IBM on an underwater acoustic monitoring and cetacean tracking system, which will be tested in SmartBay Galway.

**BioTector Analytical System Ltd: Supplying measurement technologies for environmental monitoring and water control**
BioTector Analytical Systems Limited was established in Ireland in 1995. The company has a combined expertise of over 20 years in the 'Analyzer Service Industry' which including TOC measurement. The company’s core expertise has led to the development of the range of BioTector On-Line Analyzers. BioTector Analytical Systems’ product range now consists of TOC, TN and TP measurement instruments for environmental monitoring, process control and waste minimization.

**EpiSensor: Global leader in wireless sensor network technology**
Wireless sensor network developer EpiSensor was founded in 2007 to bring the wide experience of wireless sensor networks and data collection of its founders to the marketplace. Based in Limerick, Ireland, the company has wide ranging experience in the development of wireless sensor networks around the world. EpiSensor are working with IBM to develop real-time, environmental monitoring solutions for energy, water and carbon management. The interconnecting devices integrate with existing technology investments, linking low power sensors to environmental controllers, leading to increased efficiency, improved performance, lower costs, and reduced environmental impact.
Luxcel Biosciences: Leading provider of R&D tools and solutions
Luxcel Biosciences have pioneered the development of novel screening technologies for a variety of applications in the areas of pharmaceuticals, biotechnology and healthcare diagnostics. The core technology capabilities include the use of optical oxygen sensing and respirometry. Luxcel in association with researchers at UCC have also applied their technology systems to the analysis of water quality under a joint initiative funded by the EPA and Marine Institute. Luxcel has recently entered into a strategic partnership with MOCON Inc., a global leader in gas sensing technologies and package testing/shelf life instrumentation for the food, beverage, pharmaceutical and other industries. Mocon has invested €2.5m in Luxcel and the two companies have entered into a strategic partnership which allows Mocon to develop and market instruments which use Luxcel’s sensors.

IBM: Centre of Excellence in water management, Dublin
IBM is one of Ireland’s leading providers of advanced information technology, products, services and business consulting expertise. The IBM Innovation Centre facilitates SMEs, larger businesses and universities with a focus on commercialisation. IBM hosts a Centre of Excellence in Water Management in Ireland currently employing 18 graduates (target of 30) in advanced water management; cloud computing, exa-scale and stream computing. Located in Dublin, the new facility focuses primarily on innovative research and services for monitoring, managing and forecasting environmental challenges such as the movement of pollutants in fresh water, marine and oceanic environments. IBM is accessing the SmartBay Pilot Infrastructure (currently managed by the Marine Institute) to test and demonstrate their technology platforms in the areas of data management and visualisation with application to marine and environmental monitoring needs. IBM Ireland is also key industrial partner in the SmartBay Consortium.

Intel Labs Europe: Sea-based trials of WiMax, SmartBay, Galway
Intel Labs Europe (ILE) is a network of Research & Development, Product, and Innovation Labs spanning the European region as well as variety of Intel business units. ILE works closely with academic, industry, and government institutions to advance innovations and strengthen Europe’s technology leadership in the global community. Intel is accessing the SmartBay Pilot infrastructure to trial the deployment of Mobile WiMAX in the Marine Environment. Intel is demonstrating WiMax as an enabling communications technology with applications in the areas of ocean energy development, environmental monitoring, weather forecasting, fisheries and aquaculture and tourism. Intel Ireland is also key industrial partner in the SmartBay Consortium.

Veolia Water: Leader in the provision of water and wastewater solutions
Veolia operates in four business areas in energy, environmental services, transport and water. The company has business activities in 64 countries, with over 330,000 employees worldwide with four research centres and over 300 patents. Veolia Water Ireland was established in 2004 and is a leader in the provision of water and wastewater solutions to local authorities and industry in Ireland. Key activities include; design and build operations, service and maintenance, engineering support and water metering. Veolia currently employs 180 people at offices in Kilkenny, Dublin and over 30 operations sites countrywide.
**ESRI Ireland Ltd: Global leader in Geographic Information Systems (GIS)**

ESRI Ireland, with offices in both Dublin and Belfast, is the exclusive local partner of ESRI Inc, the global leader in Geographic Information Systems (GIS). In collaboration with its customers, the company is responsible for designing and building some of the largest and most advanced GIS systems in Ireland. Employing nearly 30 professionals, the company provides solutions for business, society and the environment with clients from Government departments, Government agencies, Local Government, Utilities, Transport, Distribution and Logistics and the GIS Professional Community.

**Fairview Analytics: InSPeCT: Sea Port and Border Crossing Vehicle Monitoring System**

Fairview Analytics is a leading developer of Image Threat Detection and Analysis systems. The company’s INSPECT (Integrated Surveillance for Port Container Traffic) project with the CLARITY research centre relates to vehicle traffic analysis, and how computer vision technology, coupled with data management expertise, may increase the efficiency of traffic monitoring systems. The core technology capability of the company focuses on the development of image/video processing, event detection through visual analysis, and video management.

**Transas: World leading developer and supplier of software and hardware technologies for the marine industry**

Transas is a world-leading developer and supplier of a wide range of software, integrated solutions and hardware technologies for the aviation and marine transportation industry, including both onboard and shore-based applications. The company was founded in 1990 to provide the most advanced marine navigational systems that could be run on standard PCs. Today, the number of Transas employees worldwide exceeds 1500 people, while company’s products are being distributed and supported by a vast network of representative offices in some 110 countries.

**Wavebob: Leader in wave energy technology**

Wavebob is a leading wave energy technology companies. The company is developing a unique wave energy converter – “Wavebob”, which harnesses the immense power of the ocean to produce clean, renewable energy. The company has invested significantly in R&D over the past ten years and is now considered one of the world’s leading wave energy technologies. The company was established in 1999 and has offices in Ireland, the UK and the US.

**Automsoft: Providing worldwide communication solutions for the marine industry**

Automsoft is one of the world’s premier providers of advanced data historian and process optimization solutions. Automsoft’s technology collects, stores and analyses data to enable critical decision making. Automsoft embraces strategic software technologies including grid, autonomic computing and service oriented architectures. Automsoft is active in a number of industries including renewable energy, oil and gas, SmartGrid, power and utilities and manufacturing and maritime.
**Ocean Energy Ltd: Leader in innovative renewable energy within the wave energy industry.**

Ocean Energy Ltd specialises in the development of wave energy technology. Over the past seven years the company has developed and tested its Ocean Energy buoy technology. The OE Buoy has been designed around the oscillating water column principle. To ensure survivability the platform has only a single moving part. In February 2010, the Cork based company announced a strategic partnership with US multinational Dresser – Rand, a world renowned turbine manufacturer with a market capitalisation of €2.5 billion and 62,000 turbines operating in over 140 countries. As part of the agreement Dresser-Rand will develop and supply turbines for Ocean Energy Ltd.

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**OpenHydro Ltd: Providing world-class tidal energy technologies**

OpenHydro Ltd is a technology business company that designs and manufactures marine turbines to generate renewable energy from tidal streams. The company was formed in 2005 and has raised over €50 million from investors since it was founded. The Open-Centre Turbine is designed to be deployed directly on the seabed. Installations will be silent and invisible from the surface. They will be located at depth and present no navigational hazard. Farms of Open-Centre Turbines will provide a significant and undetectable supply of clean, predictable, renewable energy. In March 2010, OpenHydro was awarded the rights to develop a 200 – megawatt tidal wind farm off the north coast of Scotland.

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**Sea Power Ltd: Harnessing wave technologies**

Sea Power Ltd. is a wholly owned Irish Marine Engineering company with workshops and offices in Galway. It was established in December 2007 to provide a design environment to investigate ideas related to harnessing ocean wave energy. Sea Power provides a specialised platform for both the numerical design of devices, and the fabrication and testing of small to medium scale physical models for marine related projects. Sea Power has a machine workshop and fabrication facility at the Galway premises. Specialist engineers have extensive experience in the marine area and provide support for the development of technologies relating to the wave energy sector. Sea Power have direct access to seagoing service vessels and offer experienced technical services for off-shore engineering activities. A state-of-the-art Waverider Buoy is also available.
4.5 Conclusion

Ireland has demonstrated strengths in science and technology, a strong ICT cluster and a strong cluster of innovative companies in the ocean and environmental applications space.

These strengths combined provide the foundation for a leading R&D and innovation centre for ocean and environmentally related technologies with knowledge generation underpinning new products and services in related activities, extending and strengthening relationship between Ireland and the world. However, these strengths alone are not sufficient. Ultimately, the extent to which R&D is transformed into innovative products and services hinges on enabling conditions that are created in the broader economy. The key ingredients include:

- TALENTED WORKFORCE: Excellence in education to ensure a strong supply of highly qualified, flexible and innovative workers.
- PRO-BUSINESS ENVIRONMENT: Ireland placed 11th globally out of 82 countries in the 2008-2012 Business Environment ranking of the Economist Intelligence Unit.
- TAX REGIME: A key aspect of Government support for industry and RD&I is an attractive and continually enhanced tax system.

In addition, success will be contingent on constructive horizontal co-operation and co-ordination between traditional policy spheres and the realisation that Ireland the potential to build major competitive advantage in specialist niches by recognising and adopting a proactive stance in relation to the development of our largest natural asset, the ocean.
5 Research & Develop, Test and Internationalise

5.1 Introduction

The previous section outlined the strengths of our science and industry base with respect to the proposal to create a SmartOcean Innovation Cluster. This section examines existing/planned activities and specialist infrastructures which are highly relevant to the success of this strategy.

5.2 Research & Development Initiatives

There is already a strong group of companies and academic researchers actively engaged in initiatives linked to the SmartOcean Innovation Cluster. The following is not an exhaustive list and aims to highlight some of the larger relevant initiatives:

The Marine Institute and EPA have established a strategic collaboration to co-fund a range of Technology Demonstration Projects under their respective Sea Change and STRIVE programmes. These projects focus on the development of sensing and communications technology with application to marine and environmental monitoring. Specific technologies under investigation include innovative marine sensors and distributed mesh networks; optical sensing and respirometry and the development of miniaturised units for the detection of microbial pollution or toxic bloom events in aquatic environments.

The Beaufort Research Award in Marine Sensing and Communications established a Centre of Excellence in Marine Sensing and Communications Research in Dublin City University. The Centre is a flagship initiative of the Advanced Marine Technology Programme and is funded by the Marine Institute (under the NDP) to the value of €2.4 million. The Centre brings together a multidisciplinary team of researchers based in the National Centre for Sensor Research (DCU). The team are applying their current expertise in biosensor development, analytical science, remote sensing, high speed separations, optical sensors, biochip platforms, video imaging; image processing and information extraction to the development of innovative technology solutions for the marine environment.

The SmartBay Consortium comprises representatives from leading academic and industrial research centres actively engaged in the development of technology and related R&D activities with potential application in marine and environmental monitoring. In July 2009, a consortium of researchers from Dublin City University (DCU), National University
of Ireland Galway (NUIG), National University of Ireland Maynooth (NUIM), University College Cork (UCC), Marine Institute, IBM and Intel submitted a joint proposal to the HEA under PRTLI Cycle V. The SmartBay proposal (€10m) seeks to expand the current pilot infrastructure currently operated by the Marine Institute. The proposal seeks to resource a national marine test and demonstration facility through the provision of an open ocean technical platform to be managed by a dedicated professional team.

The **MERC (National Maritime & Energy Cluster) consortium**, seeks to promote Cork as a location for world class maritime and energy research and development. MERC builds on significant investment in maritime research and training in Cork, including the €50+ million development of NMCI and €15.6million in research awards to University College Cork from the prestigious Beaufort (Marine Institute) and Griffith (SFI) programmes in 2007. The MERC consortium brings together a critical mass of expertise from University College Cork with the National Maritime College of Ireland, including the Cork Institute of Technology and the Irish Naval Service as well as the Port of Cork. Strategic links have also been made to relevant statutory and commercial organisations.

Enterprise Ireland is actively working with a range of companies developing linked **Industry Led Research Partnerships (ILRPs)**. The **Ocean Energy ILRP** seeks to support the development of a research agenda set by the marine renewables sector which will be delivered through the funding of high calibre third level researchers. The **WISEN Sensor Group** comprises a network of organisations drawn from Industry (indigenous SMEs and multi-nationals, comprising both technology providers and users), university research centres and government agencies, focused on the development of wireless sensor networks as a key enabling technology for society. The **Water Technology ILRP** seeks to identify key industry needs in the areas of water technologies and wastewater treatment and initiate a programme of relevant research in the third level sector. The Marine Institute and the EPA are contributing to these programmes by mapping opportunities, highlighting related initiatives and facilitating introductions to a significant existing network of researchers and stakeholders with relevant expertise.

The Sustainable Energy Authority of Ireland (SEAI) is leading the development of the **Marine Renewables Sector** in Ireland. Key initiatives include overseeing the development and implementation of the National Ocean Energy Strategy through the work of the Ocean Energy Development Unit (OEDU). The OEDU administers an Industry Prototype Development Fund to stimulate and fund the development and deployment of ocean energy devices and systems. The OEDU has also supported the development of an Irish Marine Renewables Industry Association (MRIA) and is supporting and funding the enhancement of National Wave Basin (Cork) and National Ocean Test Facilities in Galway Bay and in Belmullet.
In addition to the large scale initiatives outlined above, there are a large number of existing research performers within the HEI system in Ireland active in significant related national and international research projects which were outlined in Sections 4.

5.2 Innovation Test Beds

Currently there are 10 Irish research, test and demonstration platforms in operation which are relevant to the SmartOcean Innovation Cluster. These are designed to facilitate R&D in a diverse range of environments (e.g. ocean, coastal, freshwater) enabling the development and commercialisation of a wide range of ocean technologies, products and services.

Existing Irish marine/freshwater research, test and demonstration platforms include:

**SmartOcean Research & Demonstration Platforms**

**SmartBay, Galway**

The SmartBay Pilot Project in Galway Bay (supported by the Marine Institute and EPA) is designed to be a research, test and demonstration platform and innovation test bed for new ocean technologies developed by research institutes and companies e.g. communications, informatics, instrumentation and sensors. The core infrastructure comprises a suite of commercially available technology. This includes a network of buoys, sensor hardware and communications systems against which prototype products or services can be validated. The infrastructure and associated data is managed and maintained by the Irish Marine Institute.

**Smart River/Coast: Flood Monitoring – Dublin Area**

The Smart River/Coast Flood Monitoring system is part of the Dublin Area Storm Surge Prediction and Management System (TRITON), operated by Met Éireann and Dublin City Council. It consists of an increased density of on-line and near real-time tide gauges (part of the National Tide Gauge Network, coordinated by the Marine Institute). The effectiveness of this infrastructure over recent years highlights the value of this relatively low cost decision support tool.
Hydraulics and Marine Research Centre (HMRC), University College Cork.

HMRC is a Centre of Excellence for ocean renewables and coastal engineering. The centre houses facilities for wave simulation with a Wave flume and an Ocean Wave basin. The facilities provide a testing environment for all phases of wave energy device development. Computer models of wave climate are validated with actual recorded data from the ¼ scales test site in Galway Bay and the full scale test site in Belmullet. HMRC are active partners in a number of collaborative EU projects on wave energy (e.g. CORES, EQUIMAR, MARINA, ORECCA).

Quarter Scale Wave Energy Test Site, Galway Bay.

The Marine Institute, in association with the Sustainable Energy Authority of Ireland, established an Ocean Energy Test Site for scaled prototypes of wave energy devices in Galway Bay. The Test site is situated off Spidéal on the north side of Galway Bay in 21-24 metres of water. Real time wave information is available for the Galway Bay Test Site. In 2010 two ocean energy device companies are scheduled to continue testing on the site.

Full Scale Grid Connected Ocean Energy (Wave) Test Site, Co Mayo

Sustainable Energy Authority of Ireland (SEAI) is currently leading the development of a full scale, grid connected offshore ocean energy test site at Belmullet, Co Mayo. The site is being developed in partnership with the Marine Institute, ESB and Tonn Energy Ltd and is expected to be operational in 2012. The site will be connected to the national grid and will provide facilities for the testing of full scale devices in development by Irish and multinational companies and will accommodate up to three devices at any one time. The site is three to six kilometres from the shore, in depths of up to 100 metres.

Tidal Energy, Strangford Lough, Northern Ireland

Strangford Lough is a site of research into the generation of clean, renewable electricity. Marine Current Turbines (MCT), one of the world’s leading developers of tidal stream energy is carrying out a multi-million pound pilot project aimed a investigating the potential of generating electricity using the Lough’s strong currents. The site enables Northern Ireland to showcase the commercial potential of tidal stream energy.
Smart Freshwater Research & Demonstration Platforms

Smart Catchment – Newport, Co Mayo
The Marine Institute maintains a network of automated catchment monitoring instrumentation at its research facilities in the Burrishoole catchment, Newport Co. Mayo. Data for the catchment, including a suite of water quality (since 1996) and fisheries data (since 1955); represent one of the longest time series available in Ireland.

Smart River – River Lee – Co. Cork
The River Lee (Co. Cork) Deploy Project (2008-2010), funded by the Marine Institute and the Environmental Protection Agency (EPA), DEPLOY is a technology demonstration project which aims to show how state of the art technology can be implemented for cost effective, continuous, real-time monitoring of a river catchment. The DEPLOY project is seen as an important building block in the realisation of a wide area autonomous network of sensors capable of monitoring the spatial and temporal distribution of important water quality and environmental target parameters.

Smart Marine-Ocean Real-Time Data Networks

National Weather Buoy Network
The Irish Marine Weather Buoy Network, managed by the Marine Institute, is a national network designed to improve weather forecasts and safety at sea in Irish and European waters. The data buoy network provides vital data for weather forecasts, shipping bulletins, gale and swell warnings as well as data for general public information and research. The Network comprises 6 offshore buoys that gather real-time weather and oceanographic data from around the Irish coast. Data is also downloaded by EUMETSAT for regional weather forecasts and is used by a number of commercial companies for specialist data products and services (e.g. Nowcasting International Ltd).

National Tide Gauge Network
The Irish National Tide Gauge Network is an on-going development involving the Marine Institute and a number of organisations in the public and private sectors. The aim is to develop a permanent tidal monitoring infrastructure, ultimately consisting of between 35 and 40 stations. Currently there are 17 active stations located around the island of Ireland transmitting tide level information in near real-time.
The products from the network are wide-ranging and include: Real-time data to an Internet site to support recreational users, navigation and commercial activities; tidal predictions; flood warnings; long term sea level variability.

**Floating Research and Demonstration Platforms**

**National Research Vessel Fleet**

The Marine Institute operate two purpose-built, state-of-the-art, research vessels, the *RV Celtic Explorer* and the *RV Celtic Voyager* and a deepwater Remotely Operated Vehicle (ROV) *Holland 1*. Both vessels are fully equipped with state-of-the-art scientific instrumentation, laboratories and IT equipment and are used for a variety of applications including fisheries research, environmental monitoring, seabed mapping, oceanography, seisments surveys, student training and meteorological investigations.

**SmartOcean Observation, Research & Demonstration Platforms – in the planning stage**

**The Porcupine Abyssal Plain Deep Sea Observatory**

The Porcupine Abyssal Plain Deep Sea Observatory, off the south-west coast of Ireland, is one of 11 cabled observatories planned by the EU ESONET (European Seafloor Observatory Network of Excellence) and EMSO (European Multidisciplinary Seas Observation) Initiative.

The ESONET/EMSO initiative has prepared a framework and strategy for the establishment of a European network of multidisciplinary ocean observatories consisting of a cabled network of 11 Seafloor Observatories stretching from the Arctic Ocean to the mid Atlantic Ridge and eastward to the Mediterranean to the Black Sea.

Discussions are on-going within the ESONET/EMSO consortium regarding the relative merits (e.g. cost benefits, feasibility, etc) of a fixed cabled versus a MODOO approach. The MODOO (MOdular and mobile Deep Ocean Observatory) concept consists of a stand-alone observatory that is mobile (or re-locatable).

A MODOO demonstration mission is planned for April 2010 at the Porcupine Abyssal Plain (PAP) site, 350 nm off southwest Ireland. The MODOO demonstration will utilise one of the deepest acoustic links from the deep seafloor to the surface integrating the existing water column observatory (EuroSITES) with a benthic lander observatory (MODOO) into a single, real-time accessible observatory.

Collectively these platforms create the core infrastructure for the SmartOcean Innovation cluster.
Figure 4: Core Infrastructure for SmartOcean Innovation Cluster
5.3 Internationalise

Critical to the development of any cluster is the development of international alliances and networks, success in competing for international research funds and involvement in major international strategic programmes.

5.3.1 Influencing the International Agenda

Ireland, as a full Member of the European Union, can and does influence EU policy (e.g. industry, environment, energy, transport, etc) and research (e.g. EU Framework Research Programme) and development support frameworks (e.g. Structural and Regional Development). This is achieved through active national representation on various EU Policy and Research Advisory Panels, Programme Committees and Expert groups.

These EU policies set out the aims and objectives, and research and innovation requirements, of developing Europe’s marine and maritime economy and provide an important policy framework for this to happen. For example, Ireland was instrumental in securing the statement in the introduction of the EU’s €52 billion 7th Framework Programme (2007-2013) that “marine science and technology is a priority cross-cutting theme in the EU’s 7th Framework Programme”. This has greatly influenced the research topics (e.g. ICT, Energy, Bio-resources, Environment, Transport, including specialist infrastructures) supported under the Framework Programme, in turn facilitating active Irish participation in collaborative pan-European marine research projects and programmes (see Attracting International Research below).

Ireland is also an active member on a number of influential advisory bodies and research networks including for example; the International Energy Agency (IEA); the International Council for the Exploration of the Seas (ICES) and the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea (UNICPOLOS). At a European level, this includes: the EU Global Monitoring for Environment and Security (GMES) Programme; the European Global Ocean Observing System (EuroGOOS); European Maritime Safety Agency (EMSA) the European Marine Observation and Data Network (EMODN); the European Ocean Energy Association (EuOEA); the European Space Agency (ESA); the European Strategy Forum for Research Infrastructures (ESFRI); the Marine Board-ESF, and the Oslo and Paris Commission (OSPAR), etc.

5.3.2 Attracting International Research

Irish researchers make good research partners. Currently (2007-2009), Irish marine researchers and SMEs are participating in 43 collaborative FP7 marine research projects and a further 22 collaborative INTERREG-IV (Regional Development Fund) marine projects. On the basis that each collaborative project has on average of 10 partners, this represents linkages with over 600 foreign research partners.
In addition, a number of Irish SMEs and Research Institutes are partners in collaborative European ocean observing and marine technology project proposals, relevant to the SmartOcean Technology Cluster, which are currently being evaluated by the EU FP7 Programme (e.g. FP7 2009 Call for Proposals).

**Irish participation in the EU FP7 Programme (2007-2013)**
The EU Framework Programme (FP) for Research and Technological Development is an important facilitator in the internationalisation of Irish research and offers Ireland's SMEs, multinationals, and research institutions valuable opportunities to participate in high-calibre co-funded research collaborations with our European counterparts.

To-date (2007-2009), 546 Irish applicants within 448 research proposals have been successful in the highly competitive 7th Framework Programme, giving an overall Irish success rate of 23.5% (the European Member State average is 21.6%). Ireland's total drawdown in FP7 to date is €152 million. Expressing total funding obtained as a percentage of the budget available to participants this gives an overall figure of 1.24%, in line with the target set for Ireland (at €600 million and 1.25%).

During the same period (2007 - 2009), Irish marine researchers are participating in 43 collaborative FP7 marine projects (grant-aid €17.5 million). This includes public research institutions, third level institutions, 20 SMEs and four Industry Associations. The Irish marine research community has secured ~11.4% of the national take in FP7 to date and has performed particularly strongly in the FP7 Energy, Environment, Food and Transport programmes.

5.3.3 **International Partnerships**

International partnerships between Irish ocean observing and related marine technology initiatives and their international counterparts are critical to enable Ireland to tap into international expertise and access global markets. Ireland has established strategic partnerships through Memoranda of Understanding (e.g. with Canada (VENUS/NEPTUNE), USA (MARS) and Norway).

There are 4 major ocean observing programmes operating at a global / European scale. These include the international **ARGO Programme** which manages one of the most advanced and successful global ocean observing systems. The ARGO Programme uses a fleet of over 3000

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16 ARGO website: [www.argo.net](http://www.argo.net)
autonomous floats to collect temperature, salinity and current data in the ice-free oceans of
the world. Ireland is a member of the ARGO consortium. The other programmes include
Global Ocean Observing System (GOOS) the Global Earth Observation System of Systems
(GEOSS), and the EU Global Monitoring for Environment and Security (GMES) Programme.

At the international / regional scale, examples of existing Ocean Observation Platforms
include Canada’s VENUS (near shore) and NEPTURE (deep sea) observatories on the Pacific
coast; the USA’s MARS undersea-cabled platform on the Monterey Pacific coast and Wood’s
Hole Oceanographic Institution’s (WHOI) Martha’s Vineyard Coastal Observatory (MVCO),
Japan’s Dense Ocean Floor Network for Earthquakes and Tsunamis (DONET) and Taiwan’s
MACHO system.

The private sector is increasingly funding the deployment of deep sea observatories.
Examples include BP’s Deep-Ocean Long Term Observatory System (DELOS) off Angola,
West Africa and Statoil-Hydro Observatory in the Barents Sea, north of Norway.

In Europe, the two major sea ocean observatory networks, part-funded by the European
Union’s Framework Research Programme, are:

- **ESONET/EMSO**\(^\text{17}\): a network of 11 Seafloor Observatories stretching from the
  Arctic Ocean to the mid Atlantic Ridge and eastward to the Mediterranean to the Black
  Sea, including a site off Ireland’s SW coast in the Porcupine Abyssal Plain. Ireland is a
  member of ESONET/EMSO.
- **EuroSITES**\(^\text{18}\) is an integrated European network of nine deep-ocean observatories sited
  in waters off the continental shelf at depths greater than 1000m, measuring variables
  from sea surface to sea floor. Ireland is not currently a member of EuroSITES.

The SmartOcean Innovation Cluster can harness international programmes and networks
through collaborative research and infrastructure projects and access global markets in co-
operation with appropriate SMEs, MNCs and international research institutions.

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\(^{17}\) ESTNET/EMSO: [www.esonet-emso.org](http://www.esonet-emso.org)

\(^{18}\) EuroSITES: [www.eurosites.info/](http://www.eurosites.info/)
6. SmartOcean Innovation Strategy

6.1. Introduction

The SmartOcean Innovation Strategy is centred on creating the conditions and momentum for the emergence of a SmartOcean Innovation Cluster.

The concept of clusters has emerged as a central idea in competitiveness and economic development over the last decade. Recognising this fact the EU has identified strengthening clusters in Europe as one of nine strategic priorities for successfully promoting innovation.

Clusters are predominantly a market-driven phenomenon. Most successful clusters are created spontaneously as a result of natural competitive advantages, market forces or simply by chance. However, owing to dedicated cluster policies in EU Member States, notably since the end of the 1990s, there are an increasing number of cases where forward-looking public policies, business initiatives or top-class universities and research institutes have been instrumental in the emergence of strong clusters by acting as a catalyst and helping unleash the economic and scientific potential of particular regions.

Clusters clearly benefit from the presence of large multinational companies, but the integration of dynamic and innovative SMEs into clusters is particularly important in helping clusters achieve high levels of excellence and innovation. Clusters, and certainly emerging clusters, offer a very fertile environment for SMEs to innovate.

The European Commission will encourage the formation of multi-sectoral clusters and regional centres of maritime excellence, and promote a European network of maritime clusters ‘Oceans of Opportunity 2008’

An Ocean of Opportunity, EU 2008

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6.2 Creating an Ecosystem of Innovation

Ireland’s Ocean Territory is one of the greatest natural **tangible assets** that we possess. Ireland has made serious investments in the creation of **intangible assets** i.e. the intellectual property and know-how of our existing ICT Innovation cluster and other clusters. The strategic intent of the SmartOcean Cluster is to combine these assets.

The SmartOcean Cluster involves the creation of an ecosystem of innovation comprising of key stakeholders including industry partners, research centres, funding agencies and service providers. To realise this strategy this diverse group of stakeholders must work together to implement the stated vision and actions.

The diagram below illustrates the level of engagement that is already underway.

![Figure 7: Existing Map of SmartOcean Innovation Cluster 2010](image-url)
The intention is that the existing SmartOcean Innovation Cluster stakeholders will work collaboratively to:

- realise the full potential of the significant investments to date in R&D;
- create a profile for Ireland as a cutting edge location for carrying out research into specialist ocean technologies, leveraging convergence opportunities;
- leverage market intelligence and our international alliances and networks;
- commercialise innovative ocean technologies, targeting niche elements of the value chain associated with emerging marine and environmental markets;
- operate new commercial entities and public private partnership models to capture market share and address global market opportunities requiring a collaboration between technology developers, systems integrators and solutions service providers and government;
- create economic value and jobs recognising the needs of and contributions which coastal communities can make to diversifying their existing industrial base; and
- promote education and training and public awareness of the value of the oceans.

Clusters are primarily market driven therefore there should be no underestimation of the importance of the market pull towards these crucial and emerging global markets. Experience to-date however suggests that one cannot be prescriptive. The entrepreneurs, SMEs and Multinationals themselves have proved to be the best judges of the ideal target niches once they have/are engaged with the emerging SmartOcean cluster.

Creating the infrastructure and the infrastructural conditions provides the key enabling framework and represents an essential contribution by policymakers to support and influence the cluster foundation.

The following diagram illustrates all the elements that must be in place to support a vibrant SmartOcean Innovation Cluster.
The left hand side of the diagram represents the technology and policy push - the public system, government and research institutions. A key actor on this side is the Cluster Manager to co-ordinate the state support, infrastructure and knowledge diffusion.

On the right hand side we have the market pull consisting of SMEs and existing multinational companies.

As the SmartOcean Innovation Cluster emerges, and market oriented technology solutions are produced, the financial sector (e.g. Venture Capital) will engage. Prior to that, seed financing of promising ideas will be necessary. This is the realm of the entrepreneur.

In parallel, as the cluster emerges, new foreign direct investments in the ocean engineering space will find the SmartOcean Innovation Cluster an attractive opportunity to co-locate in Ireland, and their presence, which requires attraction, will add foundational structure to grow and strengthen the cluster.
6.3 Actions to support the SmartOcean Innovation Cluster

*Initiative and Innovation go together. In order to advance this opportunity the following specific actions are required as follows:*

1. Support Innovation Test-Beds for new products and services

2. Appoint a Cluster Development Manager

3. Provide an Integrated Suite of Incentives

4. Actively Broker Industry-Academic Collaborations

5. Energise & Build the Marine Consultancy and Engineering Sector

6. Facilitate Market Development

7. Deepen Strategic International Alliances

8. Attract FDI & International Research

9. Agree and Pilot New Forms of Public Private Partnerships
1. Fund and support a range of innovation test-bed opportunities from river basins through to coastal and deep water environments for conversion of R&D outputs into new products and services

The emerging SmartOcean Technology Cluster will be supported by a range of existing and proposed test and demonstration infrastructures located around the country to fast track the commercialisation of research and the development of new service innovation opportunities.

- The network of infrastructures is intended to bridge the post laboratory, pre-commercial gap and act as a commercial platform for the demonstration of products and services.
- The broader community network that will access these infrastructures includes national and international Research Teams and Industrial Partners (SMEs, MNCs).
- Commercialisation opportunities will be supported by National Agencies and strategic links will be established with International Institutes and Centres of Excellence.

The existing/planned innovation test bed platforms (referred to in Section 5.2.) are currently operated either on a permanent or temporary basis by a range of public providers (e.g. Marine Institute, Sustainable Energy Authority of Ireland, Environmental Protection Agency and Third Level Institutes). To advance the vision outlined in Section 1, where Ireland is internationally recognised as a location for the development of SmartOcean technologies, the SmartOcean Core Infrastructure must be adequately funded, managed and marketed in a co-ordinated and professional manner to support innovation.

Recommendations:

1. Develop as a priority within the cluster framework, a model for consolidating the marketing and co-ordinated operation (recognising that individual sites will be managed separately by a range of entities) of the core SmartOcean Infrastructure service offering to industry and the research community.

2. Consolidate investment in flagship marine innovation test bed platforms:
   - SmartBay in Galway Bay
   - Full-scale Offshore Ocean Energy Test Site – Belmullet

3. Advance, in conjunction with the European Commission and partner member states, plans to develop a major Ocean Observation Platform in Ireland as part of a European Ocean Observation Network.
2. Appoint a Cluster Development Manager

While no prescription for success guarantees the emergence of clusters, experience in other countries shows that a cluster development manager can provide the focal point which maintains convergence, communication and drives the implementation of a range of cluster building initiatives. Successful characteristics include a cluster manager with a broad network of contacts, managing measurable initiatives with a competitive element, and focused on serving strong national or regional goals.

Recommendation:

4. Due to the diversity of stakeholders and key infrastructures supporting the SmartOcean Innovation Cluster, combined with the multifocal market targets, the Cluster Manager is seen as crucial.

3. Co-ordinate and enhance the support mechanisms within the State Development Agencies to put in place an integrated suite of incentives to underpin the development of the SmartOcean Innovation Cluster

There are many mechanisms currently in place within the State Agencies which align strategically to the objectives for this SmartOcean Cluster Strategy. The challenge is to co-ordinate the existing range of mechanisms, enhance them, where appropriate, and develop an integrated suite of complementary incentives to foster capabilities, upgrade infrastructures and boost research and its commercialisation.

Recommendations:

5. The relevant State Agencies should work together to configure existing programmes, identify gaps and propose measures, where appropriate, to provide an integrated suite of support measures that will underpin the development of the SmartOcean Cluster.

6. Nominate a lead agency to co-ordinate this activity to develop a suite of integrated support measures to advance the SmartOcean Innovation Cluster.
4. Engage in active brokerage of industry-academic collaborations in convergent technology arenas capitalising on significant public investments to date and integrating the SME and MNC research base.

Market and technology convergence provides an opportunity to transform the established industrial base in Ireland while also providing entirely new business opportunities. The experience and outcomes from the SmartBay pilot project clearly demonstrates that collaboration between the ICT cluster and the marine sector provides a unique opportunity to stimulate and foster new capabilities to address convergence opportunities. Furthermore, it has resulted in new opportunities for indigenous companies to develop synergies with international companies. New mechanisms are needed to enable leading HEI researchers who are networked into the international research community to make a stronger contribution to the SmartOcean Innovation Cluster.

**Recommendations:**

7. Focus networking and clustering activities and incentives to mobilise and strengthen interactions between industry and the research community with the goal of having an industry led Ocean Innovation cluster by 2012.

8. Utilise measures such as the SFI Technology and Innovation Development Awards to enable key researchers to engage with industry.

9. Initiate an innovative International SmartOcean Graduate Programme (similar to Fulbright) designed to catalyse convergence opportunities and to achieve mobility between research institutes and industry.
5. Evolve, build and energise the marine consultancy & engineering sector as a consolidating and project management layer within the cluster.

The marine engineering (service and systems) and environmental consultancy sectors are vital to the development of a SmartOcean Innovation Cluster in Ireland. Currently this is a disparate group of mainly indigenous SME’s and the opportunity exists for this sector to grow significantly and for new players to emerge. In order for this to materialise existing players in this sector need to orientate their knowledge and skills towards the emerging markets.

**Recommendations:**

10. Map existing engineering and environmental companies and identify opportunities for extending their reach into new markets. Support existing players to engage in cluster activities and acquire new knowledge and skills. Support new indigenous companies to develop.

11. Identify key gaps in terms of existing players and work with IDA to target overseas investment to address these gaps.

6. Facilitate market development for convergent commercial solutions and new business models enhancing MNC – SME business collaboration through active brokerage.

The SmartOcean Innovation Cluster will target emerging global opportunities and challenges in the marine and environmental sector. Experience to date has shown that clustering and networking activity between companies has already resulted in the identification of new markets. The industry stakeholders have identified a likely requirement for collaboration to combine strengths and knowledge to address and in some cases mobilise these new markets. Formal mechanisms to achieve early mover advantage by integrating technology, engineering, environmental and ocean science and service delivery capacity should be designed to deliver innovation and economic value via the cluster.

**Recommendation:**

12. Advance the formation of a commercial vehicle for interested industry partners to pilot new business models / solutions to address emerging markets.
7. Build strategic international alliances to enhance competitive positioning and to develop new market niches focusing on key partnerships in Europe, US and Asia.

The development of a vibrant Ocean Innovation Cluster in Ireland will require the establishment of strategic international alliances to enhance competitive positioning. The economic potential of ocean and environmental technology markets is now being recognised across Europe, the US and Asia given the significant economic contributions that the oceans make to their respective economies. Ireland has already established strategic alliances with some of our international counterparts and is well positioned for the establishment of future international partnerships.

Recommendation:

13. Broker deeper engagement between cluster stakeholders and key international partners.

8. Attract international FDI and major international co-operative research projects to Ireland.

The EU Framework Programme (FP) for Research and Technological Development has always been an important element in the internationalisation of Irish research and offers Ireland’s SMEs, multinationals, and research institutions valuable opportunities to participate in high-calibre research collaborations with our European counterparts. In terms of the SmartOcean Innovation Cluster, the current FP7 Programme provides numerous supports including funding opportunities under the various Thematic Areas (e.g. ICT, Environment, Energy, etc), and the Capacities Programme (e.g. Infrastructures, Research for the Benefit of SMEs, Regions of Knowledge, etc.).

The IDA Ireland Horizon 2020 Strategy\(^2\) emphasises the importance of FDI investment for Ireland. A targeted effort to attract FDI investments in areas which address missing elements of the evolving SmartOcean Cluster should be undertaken. The Horizon 2020 Strategy also notes the need for collaborations between firms in different sectors and the scope for the development of entirely new projects requiring a new approach which stretches across firms in previously unrelated sectors. IDA, as part of this strategy, intends to showcase Ireland as the world’s biggest laboratory for companies to ‘develop, testbed and internationalise’. Via the SmartOcean Innovation Cluster, Ireland can act as an ideal location for the existing FDI base to test new technology, services or business models before launching to global markets.

**Recommendations:**

14. Secure Irish participation in 10 major international co-operative research projects relevant to SmartOcean Innovation between 2011-2013.

15. Secure FDI project investments initially targeted at addressing missing elements of the SmartOcean Cluster.

16. Agree a joint MNC/Cluster Strategy to extend the existing FDI mandate in Ireland to focus on marine related opportunities.

9. Utilising the SmartOcean Innovation Cluster, agree and pilot new governance models that enable public bodies and industry to work collaboratively across traditional boundaries where there is a clear innovation opportunity.

Increasingly new opportunities such as those emerging in the environmental space require new and innovative solutions. There may be value in taking a proactive approach to evolving new business models involving innovative public – private partnerships. The SmartOcean Innovation Cluster proposes to advance the design of new business and governance models to test new service offerings to international marine and environmental markets.

**Recommendation:**

17. Establish a joint public – private sector project(s) targeted at an area where an innovative approach is required (e.g. infrastructure and/or environmental management) and where the outcome will enable Irish companies to build up a competitive position in an emerging international place.
7 Next Steps

7.1 The SmartOcean Innovation Cluster- A Flagship Project for Ireland

The recent publication of ‘Innovation Ireland’ firmly places innovation is at the heart of Ireland’s Enterprise Policy. The Report is an important element of the Government’s Plan for dealing with the challenges facing the Irish economy in a changed world. The Taskforce sets out a vision of Ireland as a Global Innovation Hub – the best place in Europe:

To turn research and knowledge into products and services;
To start and grow an innovative company;
To relocate or expand and scale an SME; and
For research-intensive multinationals to collaborate with each other and with clusters of small companies.

The Taskforce recommends that ‘a number of carefully selected flagship projects should be set in train requiring the development of innovative new products and services, many of which will occur through cross sectoral collaboration between companies, both indigenous and multinational corporations’.

The SmartOcean Strategy Working Group proposes the adoption of the SmartOcean Innovation Cluster as a flagship project to be implemented in line with the recommendations of the Task Force on Innovation. This SmartOcean Cluster Flagship Project meets a number of specific objectives targeted in the report. In particular the opportunities to:

- Capture a significant share of the growing market for environmental, energy and clean tech goods.
- Consolidate Ireland’s green brand and green cluster.
- Take advantage of the increasing convergence of technologies leading to new types of business, new products and services, an increased blurring between formerly discrete sectors and new customer markets for many of the more traditional sectors.
- Attract international research and FDI investment.

The SmartOcean Strategy working group believes that an opportunity exists to harness the collaborative research potential established via SSTI / NDP/Sea Change investments, harness our ICT cluster of multinationals and SMEs and link them to our expanding marine capabilities to rapidly create export orientated activities focused on convergence opportunities in emerging environmental clean tech and marine markets.

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22 E.g. Environmental monitoring and climate changes solutions, water technologies, marine renewable energy
This document clearly demonstrates that the national Strategy for Science, Technology and Innovation 2006-2013 (SSTI) has successfully transformed our aspirations to develop a credible global R&D base in Ireland. Sea Change (the National Marine Research, Knowledge and Innovation Strategy 2007-2013) has seen major investments in marine R&D supporting new and enhanced research capacity, capabilities and significant infrastructure. New industries based on innovation and a scientific knowledge base must start to emerge if we are to reap the benefits of these investments.

The partnerships and projects that exist today already demonstrate there is momentum building around a common focus by industry and academics on market opportunities and technologies related to environmental monitoring, water management and marine renewable energies. This is enabled by an expanding network of marine and water research, test and demonstration platforms already in existence around the coast and in the oceans surrounding Ireland. There is an opportunity now for Ireland to gain from these developments and transform our existing industrial base creating a unique business proposition anchored in the ocean technology innovation space.