Volume 1 Issue 3

# ESONEWS

The Newsletter of the European Sea Observatory Network

CONTENTS

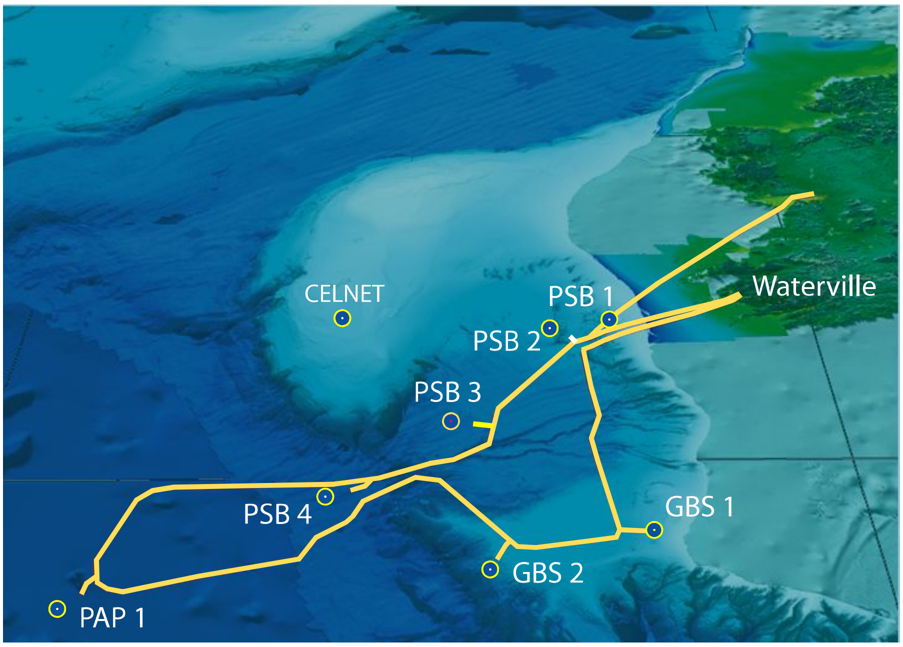


WINTER 2007

## ESONIM

## European Seafloor Observatory Network Implementation Model

The objective of the ESONIM project is to facilitate the establishment of a European Seafloor Observatory Network (ESONET) by providing EU Member State Governments with the technical, legal and financial models and arguments to evaluate and implement one or more pilot cabled seafloor observatories.
ESONIM takes the ESONET concept a step further and focuses on developing a detailed architecture and technical specification of a cabled observatory system in the Porcupine area offshore Ireland (CELTNET); a ten year cash flow forecast and projected revenue for the project and a legal framework for the procurement, construction and maintenance of the observatory. Although ESONIM has produced a practical and flexible business plan to establish a cabled observatory system based on CELTNET, the model can be modified for use at any or all of the ESONET sites.




*Proposed CELTNET cable route.*

The outputs from the ESONIM project will contribute to the ESONET Network of Excellence Implementation workpackage and the European Multidisciplinary Seafloor Observation (EMSO) preparatory phases which are now underway.

### Scientific Objectives

The scientific argument for the need to establish seafloor observatories has been established by the ESONET CA project which outlined the requirement for a long time series of data relating to geohazards, climate change and biodiversity and ecosystem function on the European margin.
ESONIM developed the scientific arguments further by considering the concerns and policy issues relevant to European states which could be addressed by an ocean observatory, such as the prediction and mitigation of climate change impacts, management and conservation of biodiversity, monitoring anthropogenic impacts, the identification and exploitation of natural resources and the study of geohazards..

# ESONIM: European Seafloor Observatory Network Implementation Model

A key objective of ESONIM was to identify end users with a commercial interest in the observatory or end users who would be prepared to pay for the high resolution data that an ocean observatory could provide. The review indicates that at present there is limited commercial interest by private sector entities (e.g. insurance and petroleum companies) in using the data and services of an offshore ocean observatory. The ESONIM partners found that the revenue generated by the ocean observatory will most likely derive from the R&D budget of marine research institutes and Government agencies with responsibility for impacts of climate change and marine resource management. However, income streams from commercial entities will most likely increase once the observatory is established and operational.
Fundamental to the ESONIM business plan was the need to quantify the magnitude of revenues likely to derive from the research community. The potential revenue of the observatory was calculated by reviewing the historical spend of a selection of EU funded research projects that collected oceanographic data in the North Atlantic, and calculating a percentage of the budget that could have been spent on data acquisition from an ocean observatory had it been in place. The review of the selected projects indicates a spend of over €1.3m on data acquisition annually within Commission funded projects, although this estimate is very conservative, as not all EU funded projects were included and national and other funded programmes were also not considered.

## Observatory Architecture

ESONIM has provided a detailed engineering solution for the CELTNET site which can be modified for use at any of the ESONET sites in Europe. The technical design study was performed by Alcatel Submarine Networks based on field proven solutions and was refined by IFREMER to present general aspects of the system and link them to scientific specifications from the ESONET project.
A robust, repeater-driven backbone cable that services primary nodes through branching units and spur cables is the ring design used to provide a link from an onshore site at Waterville to the remote deep sea sites (Fig. 1). CELTNET consists of six spurs, offering up to 6 main nodes on a backbone cable measuring 1528 km in length. The cable route was planned based on seabed morphologies and substrate type using multibeam bathymetry and backscatter data collected during the Irish National Seabed Survey. The capacity is 2 Gigabit Ethernet (GigE) per node, which can be upgraded to 8 GigE per node using existing technologies. The nodes will be serviceable by ROV equipped support vessels using procedures established by the submarine cable industry, oil exploration industry and oceanographic institutes.
Detailed estimates for the infrastructure component of the CELTNET implementation plan were also provided by the ESONIM partners. The capital expenditure for the CELTNET project is currently estimated at €81m based on a particular approach, although these costs could vary if the project is deployed on a phased basis.

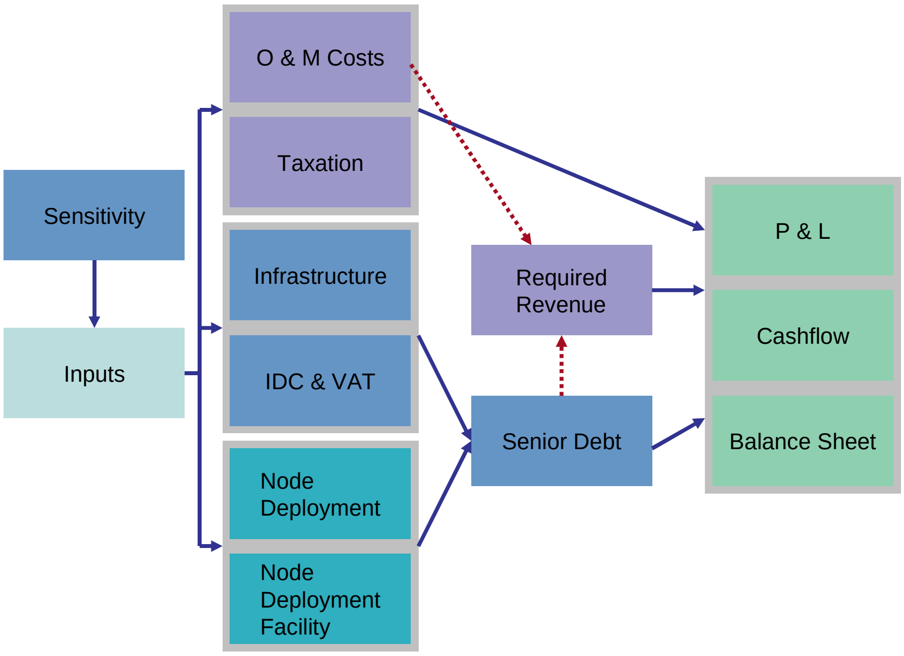
## Business Model for CELTNET

This section provides an overview of the financial model developed to produce a ten year cashflow forecast for the CELTNET observatory including CAPEX (Capital Expenditure), OPEX (Operating Expenditure) and projected revenue.
The CELTNET financial model was prepared by Goodbody Corporate Finance to estimate the financing, construction and operation of the CELTNET cabled observatory as part of the ESONIM project. The primary function of the model is to estimate (given certain assumptions regarding capital costs, funding facilities and operation & maintenance costs) the level of revenue required to support the project. Financial models of this type are generally used by project sponsors or potential investors to determine if the financial returns are sufficient to offset the risks involved in investment. The model is also used to identify:

- the project financing requirements;
- cashflows available to service debt;
- the amount of debt that can be serviced;
- the level of equity or grant aid required;
- any residual cashflows.

## Financing Structure

The objective of the financial model is to identify the optimal combination of external funding with any grant aid available from EU or national budgets. The standard approach to determining the financing of any infrastructural project is the identification of capital costs, operation and maintenance costs and revenue streams. However, the CELTNET project cannot be modelled in a conventional manner given the limited commercial interest and the uncertainty in potential revenue streams from research institutes, governments and the EU.
The model was modified by inputting the capital and operational costs and predicting the level of revenue required to make the project viable. Considerable flexibility was incorporated into the model in order to replicate a phased deployment of the infrastructure, particularly the gradual deployment of the nodes and scientific packages on the nodes. The flexibility allows the model to be adjusted as each element of the project becomes more defined and to simulate the gradual build-up of experiments over time.
There remains a significant issue relating to the upfront cost of putting the cable in place. In order to attract additional funding from banks, the project will have to have sufficient underwriting of the risk. An alternative option is to have the deployment of the cable funded with 100% grant aid, a scenario which can be run through the financial model.
Although a number of sources of finance were investigated such as equity finance, quasi-equity and bond finance, these were considered unsuitable for the CELTNET project given the low level of return and absence of well defined revenue streams from commercial entities. The most suitable funding source has been identified as Senior Debt from commercial banks or from the European Investment Bank (EIB). However, support from the EU, governments or research institutes and organisations must be available to attract such funding. In the absence of such support it is unlikely that the project would be able to obtain investment in the form of senior debt.
It is therefore likely that CELTNET will require significant up front grant-aid from the EU, member states and research bodies willing to pledge long term revenue to the project.




## Financial Model Structure

One of the key outputs from ESONIM is the availability of a financial modelling software tool. The model allows assumptions to be made about capital costs, node deployment costs, operating and maintenance costs, senior debt facility, levels of capital grant, revenue generated, number and timing of scientific payloads deployed etc. The model can be modified or extended to assess the feasibility of planning, constructing and operating a cabled seafloor observatory at any or all of the ESONET sites.
The structure diagram illustrates the main interactions between the worksheets and inputs in the model.

## Financial Model Inputs

There are three principal components of the model inputs and they relate to:

1. Capital Costs
2. Operating and Maintenance (O&M) Costs
3. Revenue Estimates

### Capital Costs

The capital costs for the infrastructural component of the project are based on the estimates of Alcatel and are indicative only (Table 1). The capital costs for the node deployment have been adjusted to allow for the phased deployment of 5 nodes in water depths less than 3,500 m and total €81.4m.

### Operating and Maintenance (O&M) Costs

The costs involved in the daily operating and annual maintenance costs are also input to the model and are based on estimates from project partners. The total O&M costs for CELTNET are estimated to be €1.2-2.3m per annum over the lifetime of the observatory, although this could be reduced if a deep water vessel is not required to service the maintenance of the backbone cable.

## Revenue Estimates

The purpose of the Potential Revenue calculation is to assess and illustrate the feasibility of the project meeting the level of revenue required to finance and operate it. The potential revenue is the level of income that may potentially be available to the project from the deployment of scientific payloads on CELTNET by research projects. The potential revenue for an ocean observatory was calculated by reviewing the significant historical spend by European marine institutes and research organisations on the collection of oceanographic data in the North Atlantic. The review indicates a conservative average annual spend per research project of €180,000 on data acquisition alone (Section 2.0). Experience has shown that many public private partnership projects offering superior infrastructure attract a higher level of usage than initially estimated.

| INFRASTRUCTURES CAPITAL COSTS (€) | |
|---|---|
| Infrastructures Studies and Surveys | 4 000 000 |
| Engineering and Project Mgt / Acceptance and Comissioning | 6 423 563 |
| Backbone Submarine Cable | 12 802 552 |
| Backbone Wetplant (Repeaters and Equalizers) | 3 945 940 |
| Backbone Marine Operation (Without Survey) | 10 096 297 |
| Land Cable Civil Works & Shelter with Energy | 2 686 506 |
| Shore Station Equipment | 2 214 894 |
| Telecom Shore Station Equipment and Network Mgt System | 1 297 057 |
| Training and Documentation | 224 652 |
| Wet Plant and Marine Operation from BU to TRF for 5 nodes (depth < 3500 m) | 12 098 217 |
| Generic Instrumentation | 13 000 000 |
| Marine Operations for Generic Instrumentation | 2 000 000 |
| Sub-total | 70 789 678 |
| Contingencies (15%) | 10 618 452 |
| Total | 81 408 130 |

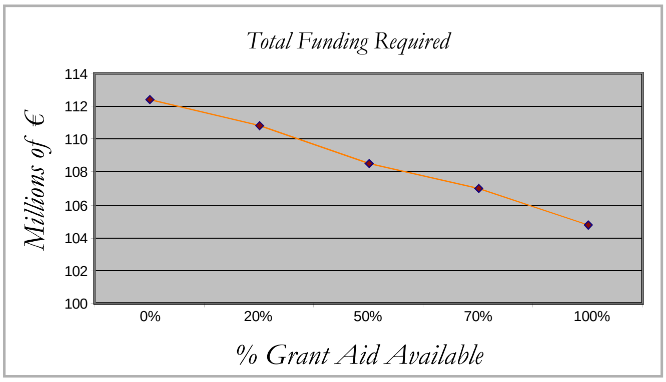
## Financial Model Outputs

### Total Funding Required

One of the fundamental questions about the implementation of CELTNET is how much will the project cost? This has been assessed for the phased deployment of the observatory infrastructure as outlined in Section 4.3.1 and 4.3.2. The Total Funding Required includes the total cost of the infrastructure (€81.4m), in

# ESONIM: European Seafloor Observatory Network Implementation Model

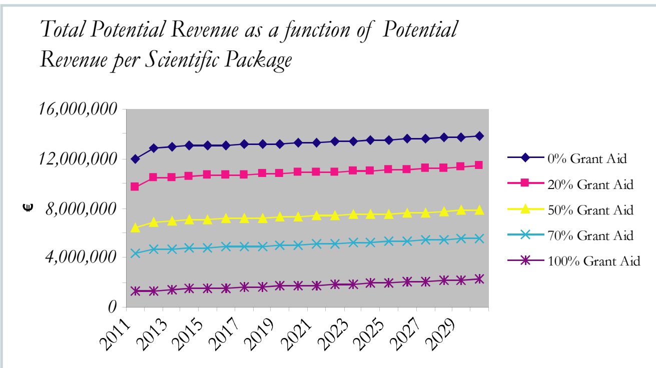
addition to the cost of deployment of the cables and nodes plus the ancillary costs associated with servicing any senior debt incurred by the project. Different funding scenarios have been examined to look at the relationship between the Total Funding Required for different levels of Grant Aid available.
The total funding required is inversely related to the proportion of grant aid available, as required revenue must be increased to service capital and interest payments on the Senior Debt. The study shows that the phased deployment of the observatory architecture could cost between €104.8-€112.4m depending on the level of grant aid (or free equity) available to the project.




Total funding required as a function of the percentage of grant aid available.

## Required Revenue

An important output of the model plots the Required Revenue to meet the Debt Service and the Required Revenue to meet O&M Costs. As was illustrated in Section 4.4.1, there is a correlation between the required revenue to meet the debt service and the proportion of Grant Aid available to the project. For the CELT-NET site, the model indicates that the required revenues to meet debt service range from zero, for 100% Grant Aid, to in excess of €11.5m annually if no grant aid is available.
The Required Total Revenue is the level of revenue required to meet the both the Debt Service and O&M costs of the project (Section 4.3.2). The addition of the Required Revenue to meet the Debt Service and the Required Revenue to meet O&M costs gives the Required Total Revenue. The Required Total Revenue as a function of grant aid available is plotted below.




*Required total revenue as a function of grant aid available.*

The graph illustrates the large variation in revenues that may be required if a large proportion of the infrastructure is underwritten by debt. For a 100% Grant Aid scenario, the total required revenue is equivalent to the O&M costs only. The Total Required Revenue is the benchmark against which the viability or otherwise of the project will be measured and this is achieved by comparing the Potential Revenues which may be available by the deployment of scientific instruments on the nodes

## Potential Revenue Profile for each Node

The Potential Revenue is calculated by multiplying the number of scientific packages assumed to be active on a particular node by the assumed average research project spend on data acquisition. In the example below scientific packages are deployed on a phased basis over a four year period and remain constant for the remainder of the project. The average revenue spend per instrument package is assumed to be €180,000.

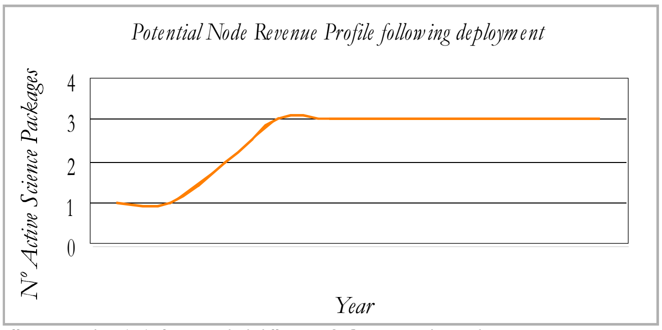
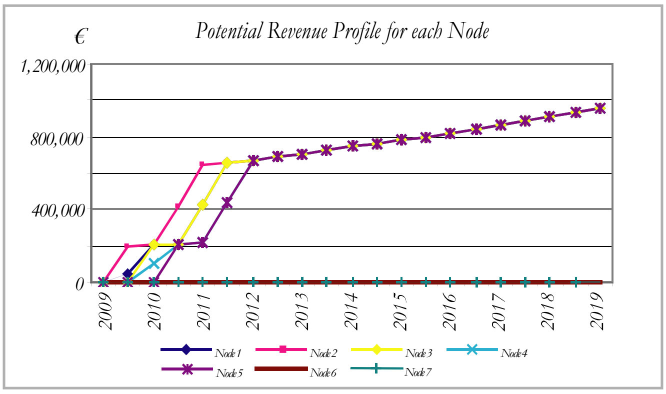


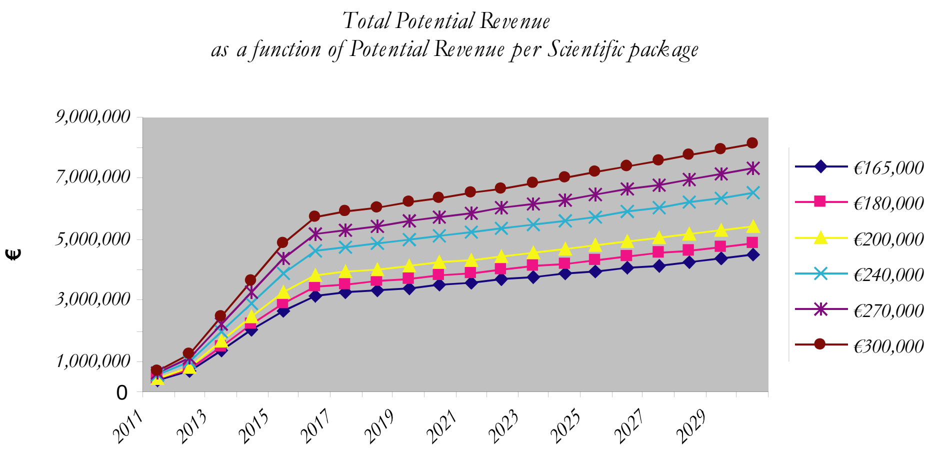

*Illustration of node deployment which follows an S-Curve rate of growth.*




*Potential revenue profile for each node assuming 10 scientific instrument packages per node.*

## Total Potential Revenue

Potential Revenue is the level of revenue that may potentially be available to the project from the deployment of scientific packages on CELTNET and is derived by summing the revenue streams per node over the lifetime of the project (Section 4.4.3). It should be noted that the model is extremely sensitive to the assumptions made with respect to potential revenue generation calculations. This is illustrated in the diagram below whereby the revenue per scientific package is adjusted from €165,000 - €300,000. The resulting

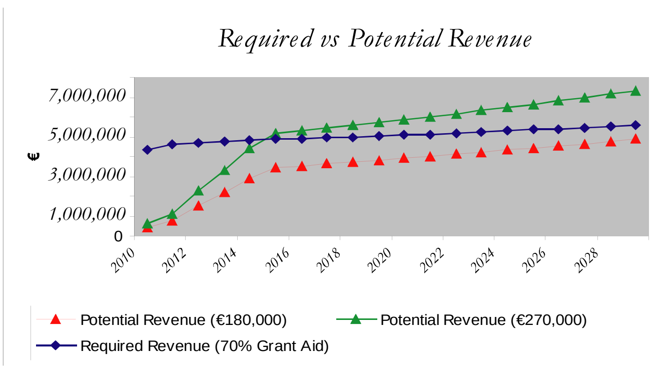



*Total potential revenue estimates as a function of the potential revenue income per scientific package.*

projected revenues from the lowest to the highest estimate vary by up to a factor of two. As the project develops it will be important to adjust the model for the most likely node configuration and appropriate potential revenue estimations.

## Required versus Potential Revenue

The effect of varying costs and using differing funding scenarios have been considered in previous sections as these adjustments have implications for Total Revenue Required and Total Potential Revenue available.
The model allows us to examine whether the observatory can be either self sustaining (both for infrastructural and O&M costs) or whether there is a likelihood that revenues will be insufficient to make the project feasible. This is best achieved by examining the final model output – a graph of the Required versus Potential Revenue. Any funding gaps (or potential profits) are visually represented on this graph.
The CELTNET model has been run for the state of the art observatory architecture, a capital cost of €81.4m, a phased deployment of nodes and 70% grant aid . The potential revenue has been calculated using two different revenues per scientific package (€180,000 & €270,000). The results are plotted below :




*Required versus Potential Revenue for a model with 70% of CAPEX grant aided and two estimates of the potential revenue per scientific package.*

The model shows that the potential revenues may not be sufficient to cover the CAPEX and OPEX if the lower estimate per scientific package (€180,000) is used. However, this figure is considered a minimum estimate and by using a higher estimate for potential revenues of €270,000 per scientific package the model clearly illustrates that the observatory would be viable within five years of operation and could operate at a profit thereafter if there is no contribution to the scientific payloads. The projected revenue figure of €5m per annum within five years is considered realistic given that the potential revenue estimation is based on each node in the observatory operating at considerably less than full capacity and the fact that the current conservative estimated annual spend by the EU on ship based data acquisition is at least €1.3m.
The financial model developed by ESONIM suggests that the CELTNET project is viable if a significant level of grant aid is available from EU, national Governments, para-statals or research institutes to underwrite the deployment of the network until projected revenues and costs achieve parity after a five year period. Once the level of support for the project becomes clearer, the model should be rerun to ascertain if the node deployment will be self sustaining from a financial perspective.

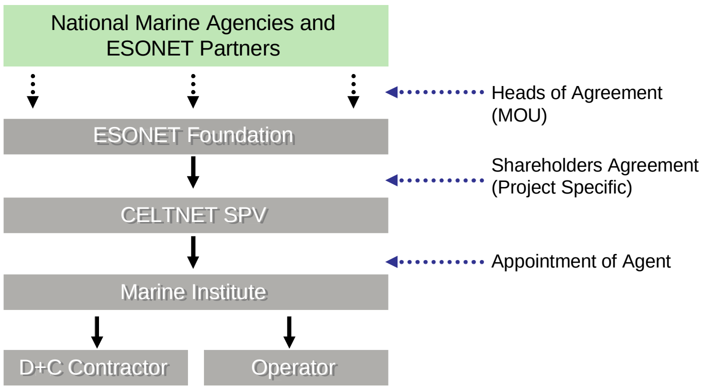
## Legal Framework

A significant body of work for the ESONIM partners involved the development of a structure for an immediate commencement of a full tender process for the awarding of a contract to design, construct and maintain a cabled seafloor observatory.
The procurement process is governed by strict EU rules and a series of model contracts have been supplied which facilitate the appropriate sharing of risk and liability associated with the design, build and operation of the CELTNET infrastructure. The contracts allow the partners to plan, manufacture, supply, install, assemble and test the CELTNET infrastructure on a fixed price, turnkey, date certain basis. Planning and environmental issues that are related to a substantial project offshore Ireland have also been considered. The project has identified a mechanism whereby the project could benefit from statutory rights available solely to local authorities

# ESONIM: European Seafloor Observatory Network Implementation Model

thereby reducing the risk of cost and time delays associated with planning applications.

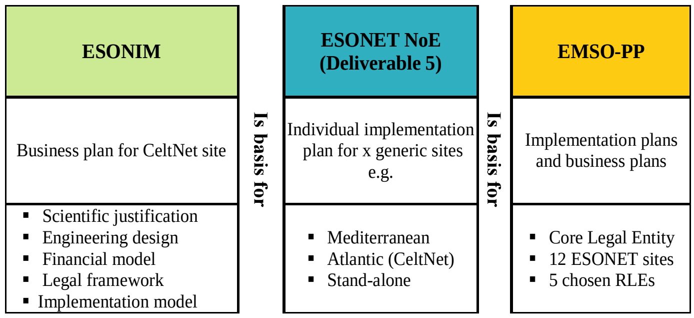
A business structure has been developed which establishes a foundation to commission and provide ownership of ESONET sites around Europe. The structure would be governed by a Memorandum of Understanding (MOU) and a Special Purpose Vehicle (SPV) would be set up to build and operate each observatory site. In the case of CELTNET the foundation would set up a company (CELTNET SPV) and it would appoint the Marine Institute as its agent to procure and manage the engineering and design and O&M contracts. A separate shareholders agreement would apply to each SPV to determine such matters as capital contributions, ownership interests, profit participation and project roles and responsibilities.




*Possible Business Structure.*

## Next Steps for ESONET/EMSO

CELTNET is a series of cabled seafloor observation sites situated in the Porcupine area offshore Ireland. The ESONIM project has established the scientific justification and technical feasibility of CELTNET. A business and financial model for the implementation of the observatory has been provided, together with the legal framework required to reduce the primary risks associated with the design, build and operation of the CELTNET infrastructure.




*Stepwise construction of implementation plans*

In conjunction with the ESONET Network of Excellence (ESONET NoE) and the European Multidisciplinary Seafloor Observation (EMSO) projects the ESONIM partners recommend that:

• the ESONET foundation should be set up via ESONET NoE and EMSO;

• the EIA and planning applications for CELTNET and other priority sites should be initiated;

• ESONET members should lobby their governments for grant aid funding;

• the EIB should be approached to ascertain the level of available finance;

• the financial and legal models are being made available to ESONET NoE and EMSO partners to develop models for other observatory sites.

# Flashes/short news

## First ESONET Training Workshop

The first ESONET Training Workshop will be held in Bremen January 27th-28th, at Jacobs University. This 2-day Training Workshop will provide ESONET postgraduates and engineers with a sound background knowledge of the key science and technology issues, presented by experts in the field who are involved in the project. Topics to be covered include canyons, corals,carbonate mounds, seeps and anoxic microbial systems. The Demo-Sites will be presented. Also included are practical workshops on planning online experiments and data management. The course is free for all ESONET members. Please take note, that the participants are expected to fund their own travel expenses. You can however apply for travel support by sending a cost statement to Autun Purser (a.purser@jacobs-university.de).

## ESONET Best Practices Workshop

The first ESONET Training Workshop will be held in Bremen January 29th-30th, at the Atlantic Hotel Universum. A focus will be made on the share of experience of past experiments (positive and negative). The state of the art will be presented (such as output from EXOCET/D, ORION, ASSEM, COBO, ESEAS, ESONIM, NEPTUNE Canada and MARS projects). Underwater engineering and research teams will analyze the state of the art, determine necessary improvements and integrate their efforts on data management, ageing, biofouling protection and other long term related R&D issues. More information on www.esonet-emso.org/

## Jobs Offers

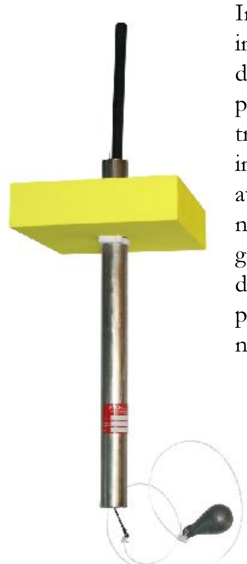
Two positions have been published by esonews mailing list, they are also available on www.esonet-emso.org/ … web site. We draw your attention on the possibility offered through ESONET for exchange of personnel. For Esonet Partners a part of the exchange cost can be refund. For more information contact Esonet coordination team.

# COMPANY PROFILE

nke is a French society created 1984, specialized in the development and production of electronic devices. It is located at Hennebont (Bretagne) and its annual turnover reaches 6 M€.
nke operates a Development Unit, which incorporates 25 engineers in the fields of electronics, mechanics and informatics. Product manufacture at nke is done by an Assembly and Test Unit with a total staff of 22 people, equipped with the needed metrology means for instrument calibration. Both development and manufacture are carried out under severe quality control specifications, nke is certified ISO-9001-2000.

SMATCH

*EMMAT*



*Autonomous pT recorder*

*Contactless serial interface*

## Product Portfolio

nke Instrumentation Department, develops since 1993 specific products and solutions in the field of Oceanography. nke proposes an important range of autonomous probes for measurements in the ocean, until 6000m depth, with a high level of accuracy (1 m°C in temperature). Physico-chemical parameters of marine water include: Conductivity, Temperature, Pressure, dissolved Oxygen, Turbidity, Fluorescence, pH, etc… Monitoring devices include: Silting, Heat Flux, Sedimentary Differential Pressure, etc… Analysis of the behavior of immersed systems include: Force, Acceleration, Slope, Traction effort, Corrosion… nke also proposes complete operational instrumented networks, due to:

- Its knowledge of instrument implementation in the marine environment (instrumented buoys, coastal benthic stations or for deep sea…),
- Its knowledge of the protocols of data exchange (TCP-IP) and the various associated transmission resources (UHF, GSM, GPRS, Iridium…),
- The development in collaboration with Ifremer of a innovating system for the protection of the sensors against bio-fouling (localized Chlorination),
- The know-how on data-processing technologies and data dissemination.

In the particular field of marine observatories nke proposes integrated autonomous systems, based on the technology COSTOF, developed and deployed by Ifremer within the framework of the projects ASSEM and ROSE. nke also proposes products for data transmission without connectors (Contact Less Serial Inductive) and information recover from seafloor instruments (Messenger and autonomous EMMAT Profiler, with Argos transmission).
nke currently cooperates with Ifremer in the development of a new generation of piezometers (PIEZO2), for the measurement of differential pressure and temperature within seabed sediments. This product could be used in particular as a sensor for underwater network of cabled observation stations.

*Instrumented buoys*

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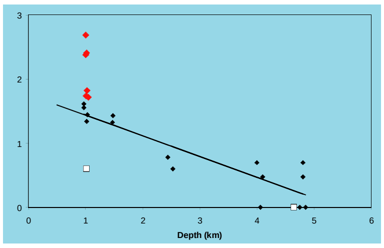
# Welcome to the last ESONEWS of 2007!

Professor Imants (Monty) Priede
Director of Oceanlab
University of Aberdeen, Scotland.
http://www.oceanlab.abdn.ac.uk/

This has been an eventful year marked by the kick-off of the ESONET Network of Excellence, an important step in progressing implementation of the observatory system. A further significant event is completion of the ESONIM study, described in this issue, which assesses in detail what is required to implement a large scale cabled observatory. The important message is that ESONET is feasible and affordable.

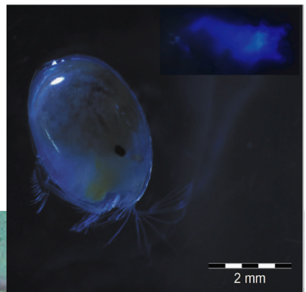
In this preface to the ESONEWS I would like to turn to a seasonal story of what we shall see in these observatories in the deep sea. A curious thing about the deep sea is that most fishes have well-developed eyes. It is well known that fishes trapped in dark caves have quickly evolved into blind species with no eyes. Nature would not allow deep sea fish to have eyes if they were useless. With ESONET we shall be able to deploy cameras on the sea floor and view the deep sea from the fishes' point of view. In the CeltNet area west of Ireland we have deployed autonomous lander platforms at depths from 500m to 4800m roughly along the route of the proposed cable. With a high sensitivity camera looking at bait placed on the sea floor we could see flashes of light, decreasing in frequency with depth from 30 per hour on the slopes to 3 per hour on the abyssal plain. This is bioluminescence, produced by deep sea animals. It is blue in colour and clearly this is what deep-sea fish must be seeing.

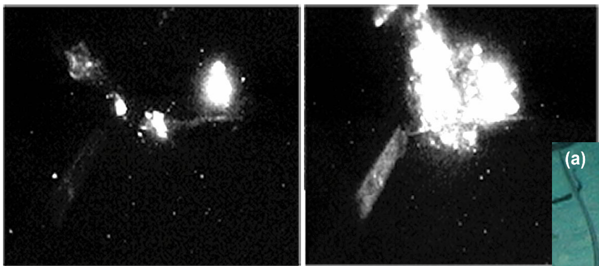



*Frequency of light flashes (Log plot) at bait on the sea floor at different depths in the Celtnet area. Red symbols are from the vicinity of deep sea coral mounds.*

However locations around the deep cold water coral mounds at 1000m depth we found "hotspots" with 100-300 flashes per hour often resulting in balls of light the size of a football. When illuminated by strobe light we could see lots of little deep sea eels (Synaphobranchus kaupii) but these fish are not known to produce light. Further investigations revealed that the deep sea light display is produced by little "seed" shrimps (Vargula norvegica, Ostracoda) that squirt blue luminescent fluid into the water to repel the eels that are trying to eat them. The Vargula in turn were biting into the skin of the eels.

*The bioluminescent biting seed shrimp Vargula norvagica*



*Development of a ball of light at a bioluminescent hotspot in the Porcupine Seabight area.*

*Views of deep sea eels, Synaphobranchus kaupii (illuminated by strobe light) fighting with the tiny seed shrimps.*


As you admire the lights on Christmas decorations spare a thought for the light displays going in the deep sea. However there is no peace and good-will down there, it is war! with light bombs!

Best wishes and peace for 2008

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