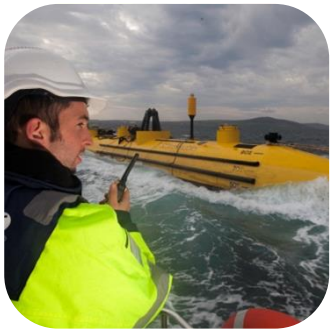
A GLOBAL CENTRE OF EXCELLENCE IN
MARINE ENERGY TESTING AND RESEARCH

EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE





Global Ocean Energy

The Next Generation

Neil Kermode
Managing Director

Marine Energy as a driver of the regional economy

Highlands and Islands Enterprise

Calum Davidson

Director – Energy and Low Carbon

The Highlands and Islands of Scotland

- A rural region on the North and West of Scotland, with a population of 450,000
- Larger than Belgium, more coast than France, with 90 inhabited islands, with a Scandinavian style of rurality
- 25% of Europe's tidal, wave and wind resource, 40 years of Oil and Gas reserves

Highlands and Islands Enterprise

- Scottish Government economic and community development agency
  - Business
  - Infrastructure
  - Policy
  - Internationalisation
  - Inward Investment
  - 250 staff and a budget of £75m+ pa
- Energy – one of 6 key sectors
- Major focus on Energy – particularly offshore Renewables and Oil and Gas

Why Marine Renewables?

Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 's nan Eilean

Ambitious for *growth*

HIE
Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 's nan Eilean

Ambitious for *growth*

Policy- Government Renewable Energy and Climate Change Targets

UK Targets –

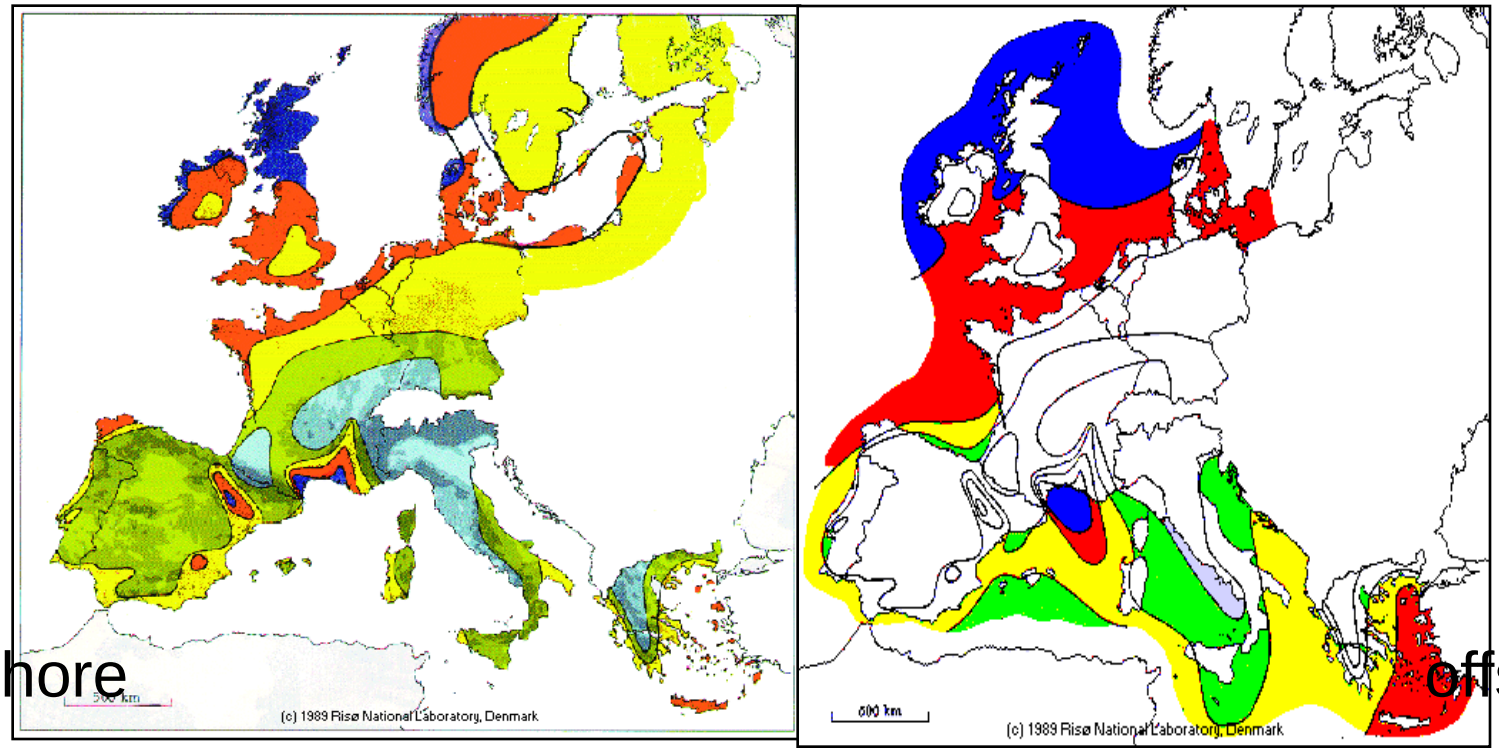
- 30% power from Renewables by 2020 - Currently at 10%
- 15% of Primary Energy from Renewables by 2020
- Kyoto target 80% emission reduction by 2050

Scottish Targets -

- 100% of electricity demand from Renewables by 2020
- 31% by 2011- Currently at 33% (2013)
- 30% of Primary Energy from Renewables by 2020
- Emission reduction target of 42% by 2020 - 80% by 2050

Scotland has 25% of European wind energy potential

Highest wind resource

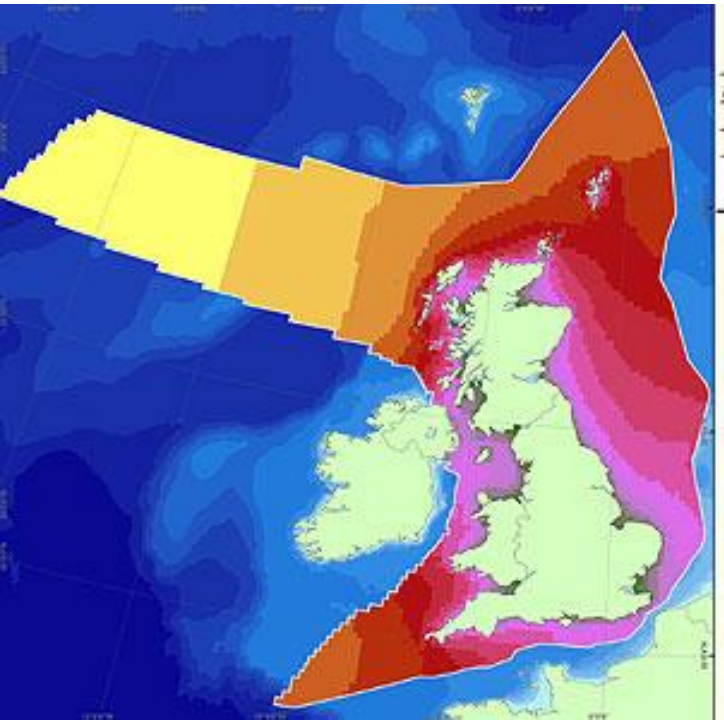


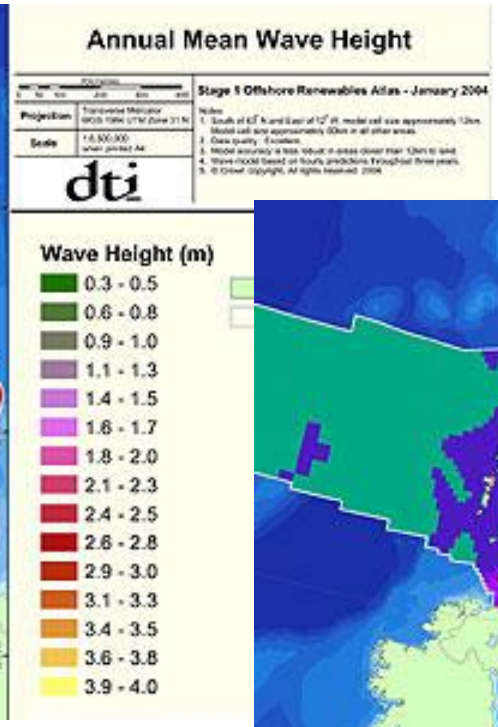
onshore

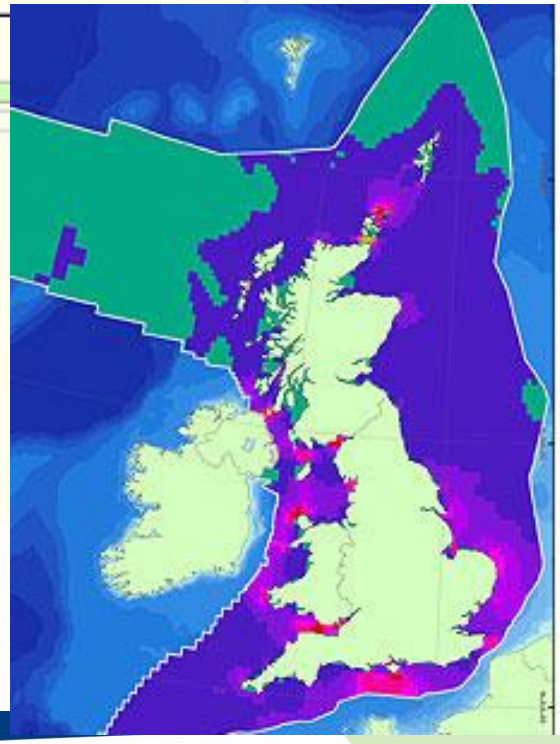
offshore

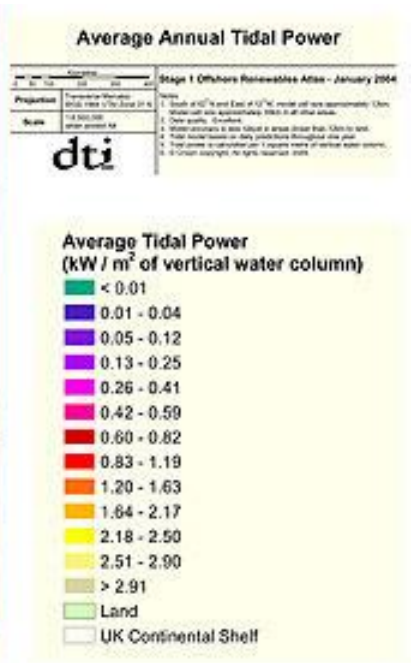
Scotland's Wave and Tidal Resource

- Scotland has over 70% of the UK's tidal Power









Scotland's position produces tremendously energetic waves

Clear opportunity to make the Highlands and Islands a global leader in a key emerging industry

And it turns the rural/urban economic development paradox on it's head….

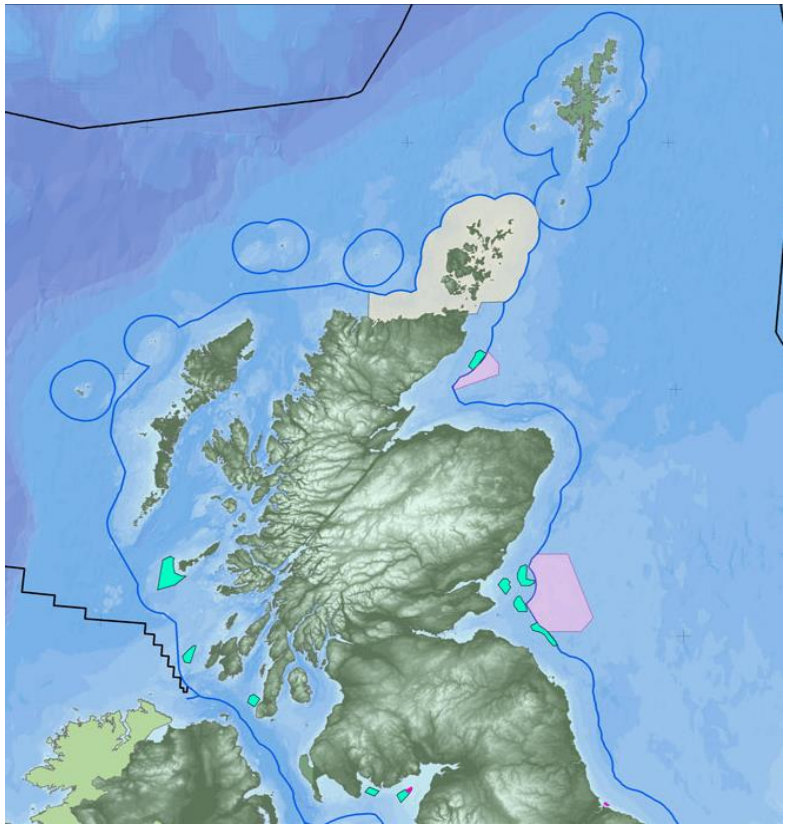
The periphery becomes the centre.

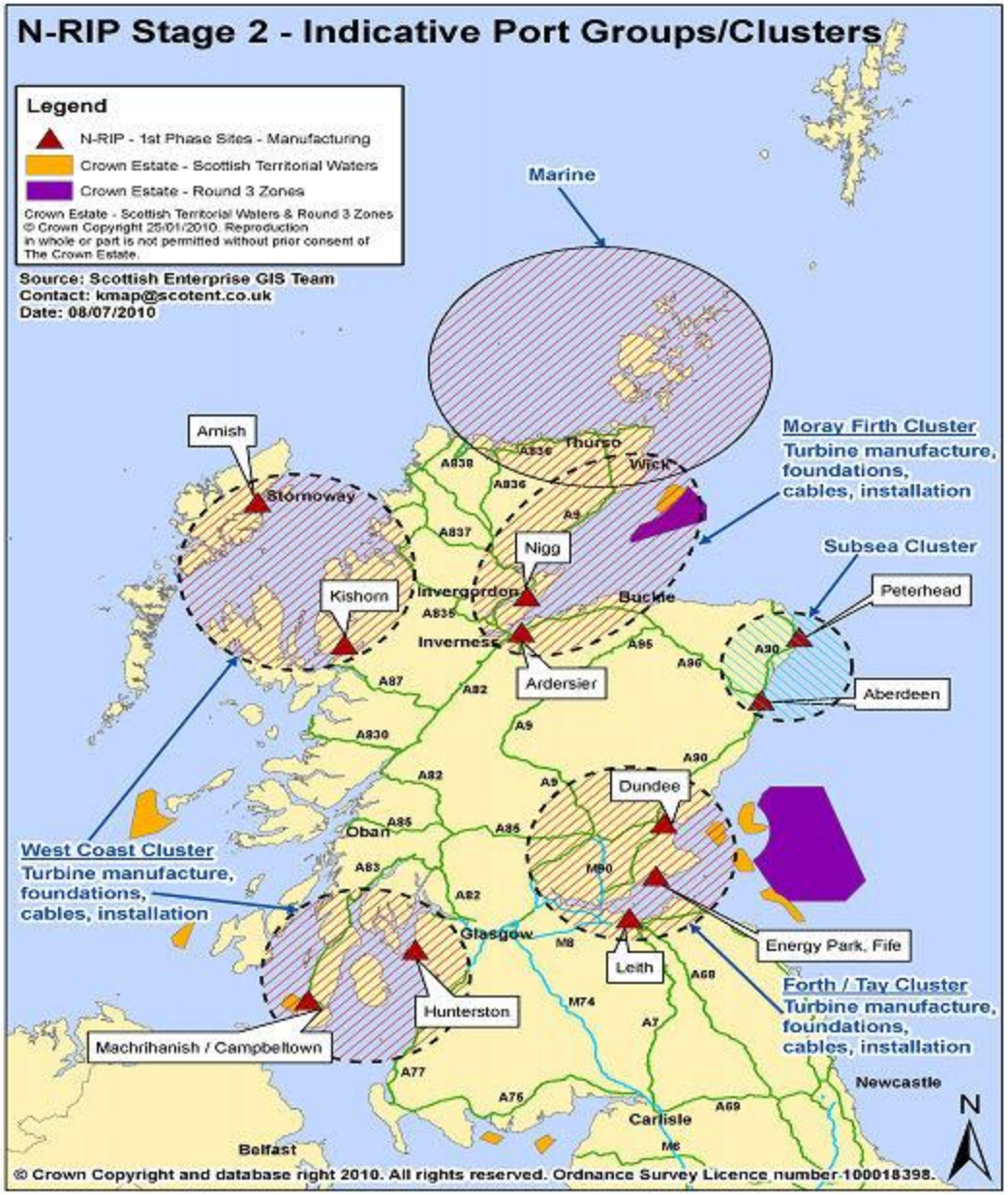
Supply Chain Opportunities

- Consenting process
- Design and engineering
- Construction and manufacture
- Deployment and installation
- Operation and maintenance
- Decommissioning

Scottish Offshore Activity

- World's first commercial scale marine leasing round - 1.6GW
- Round 3 and STW projects – potential for over 4.7GW installed in the H&I
- Scotland's peak energy demand = c6.6GW





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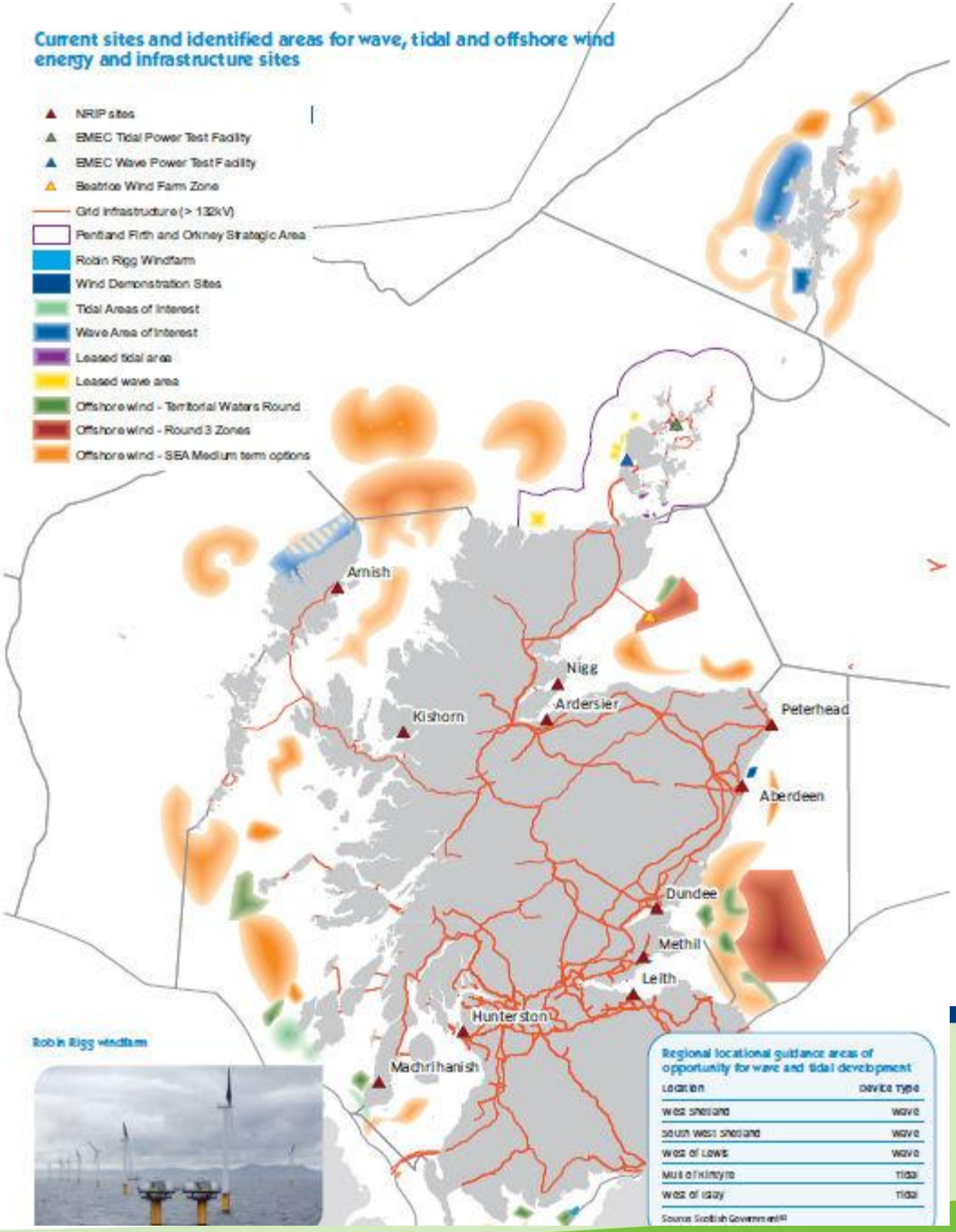
Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 's nan Eilean

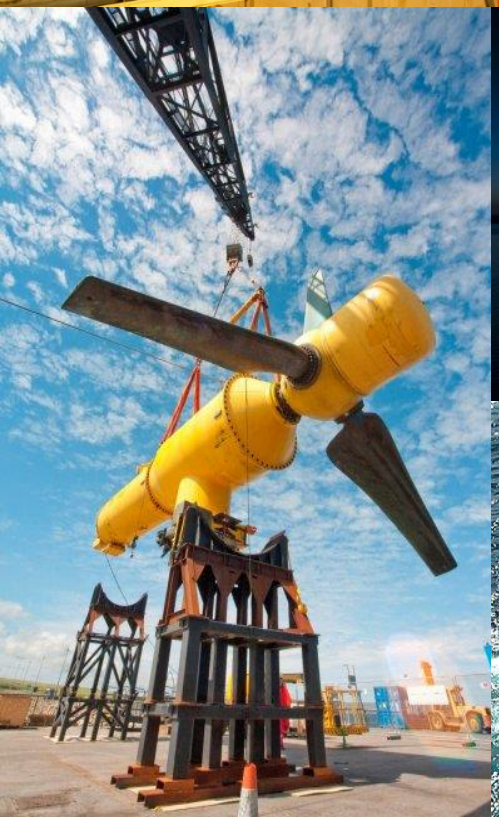
Ambitious for *growth*

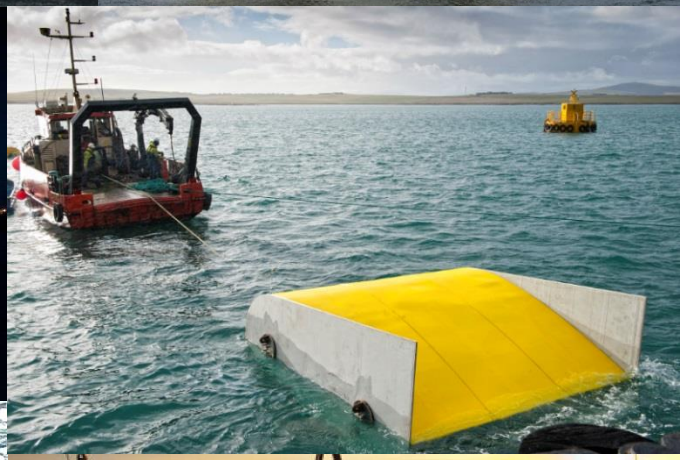
Current sites and identified areas for wave, tidal and offshore wind energy and infrastructure sites



Wave Prototypes

Tidal Prototypes





Hatston Pier

- The newly extended pier at Hatston has been utilised by 5 tidal energy developers in recent weeks – Alstom Hydro, ANDRITZ Hydro Hammerfest, OpenHydro, Scotrenewables Tidal Power Ltd, and Voith Hydro – with 4 devices currently at the quay.

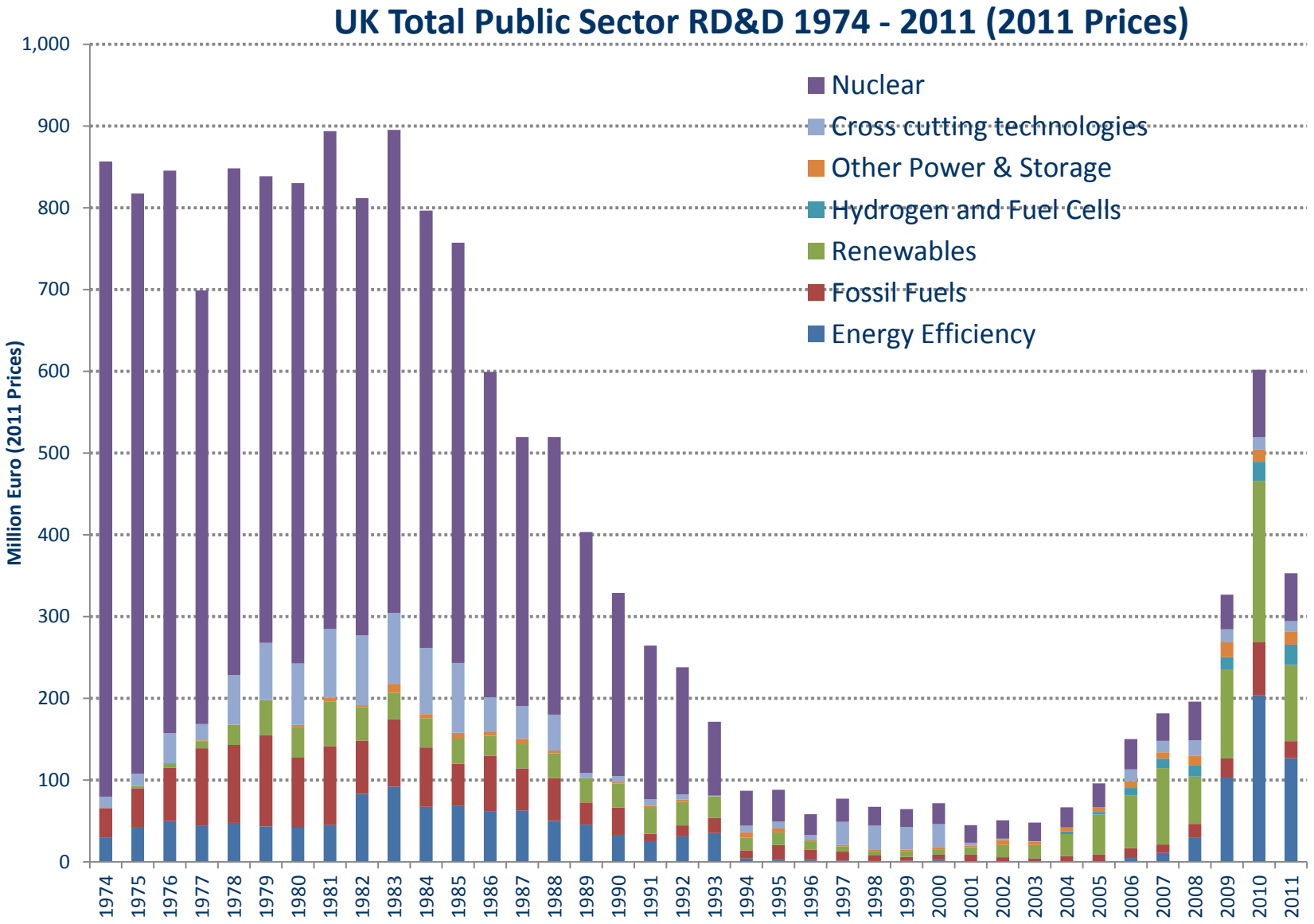
Scrabster

- Scotrenewables Tidal Power Ltd, based in Orkney, has chosen Scrabster as the location for their most recent operations and maintenance work on their prototype tidal turbine, the SR250.

How can innovative Government support advance ocean energy development?

Chris Stark
Scottish Government

17 October 2013


UK Total Public Sector RD&D 1974 - 2011 (2011 Prices)
Million Euro (2011 Prices)
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900
800
700
600
500
400
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Nuclear
Cross cutting technologies
Other Power & Storage
Hydrogen and Fuel Cells
Renewables
Fossil Fuels
Energy Efficiency
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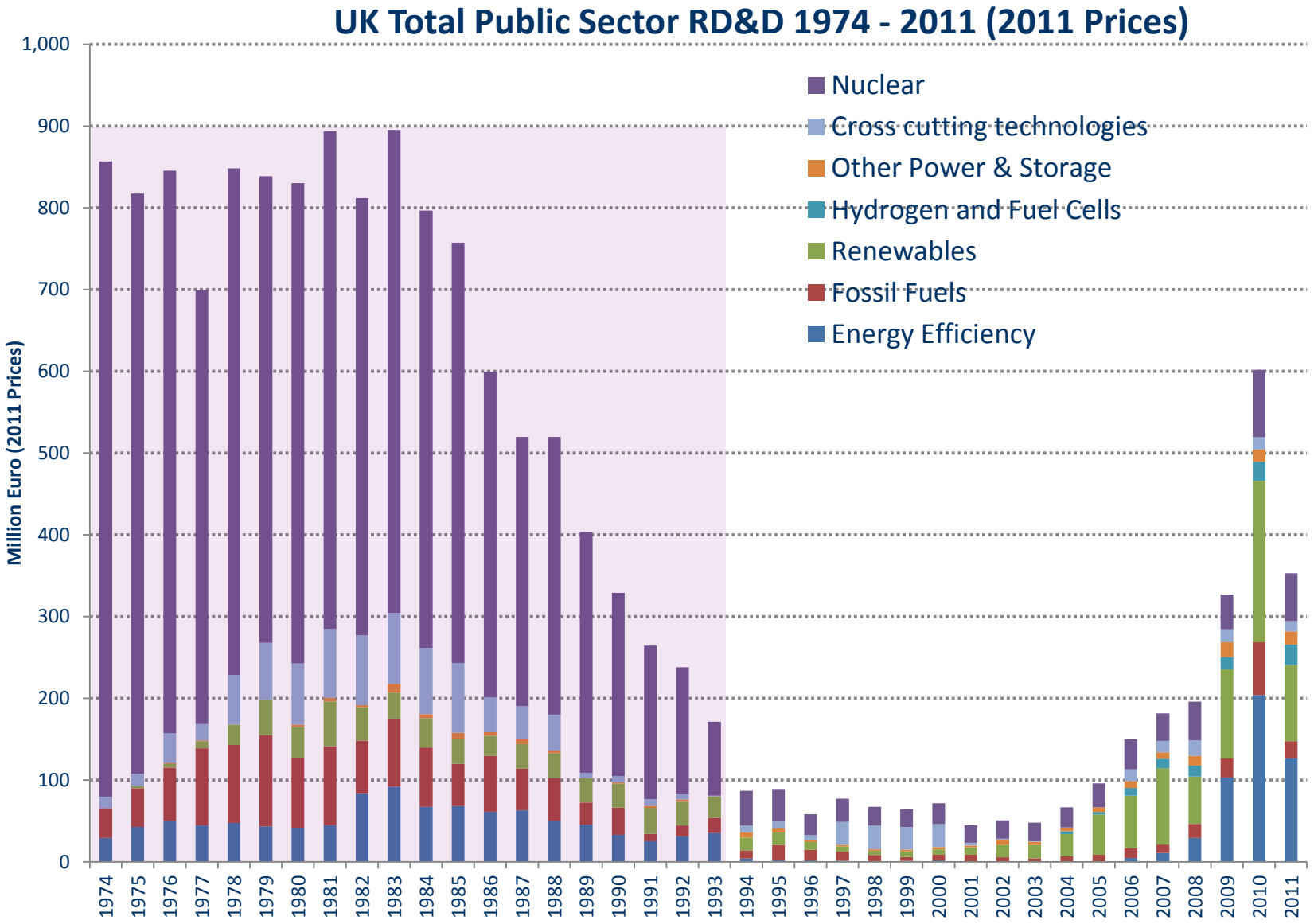
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Long term and stable support

Supply Push

- Long-term support for basic and applied R&D
- Public-Private Partnership
- R&D in Universities
- Portfolio approach

Demand Pull

- Niche Market Creation
- Early and demanding customer
- Complementary and Enabling Infrastructure
- Maintaining open markets for new entrants

Long term and stable support

Supply Push

- Renewable Energy Investment Fund
- Marine Renewables Commercialisation Fund
- Supporting Array Technologies programme
- WATERS programme

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Demand Pull

- Renewables Obligation (Scotland): Five ROCs for wave and tidal
- Saltire Prize

Four policy challenges for Scottish marine renewables

1 Reframing the challenge

- This is still a public R&D project, not yet commercial electricity generation
- Technology development and resilience remain the key
- Still viewed as benign – but plan for the future competitive threats

2 Addressing market uncertainty

- Reforms of the UK energy market
- Projecting a consistent market opportunity
- Reserving a space in the future generation mix
- Government as a customer?

3 Attracting investment

- Aggregation of projects
- Utility investment (now or later?)
- Institutional investment at a sectoral level
- International collaboration to increase project size

4 Enabling infrastructure

- Removing the perception of grid as a barrier
- Seeking an interim solution to massive infrastructure investment on the regulated asset base
- Growing testing and deployment to array scale – remaining flexible

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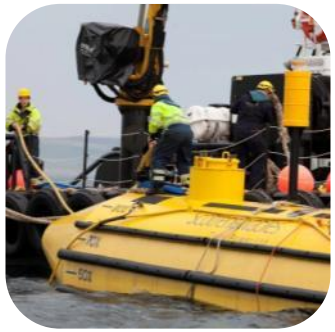
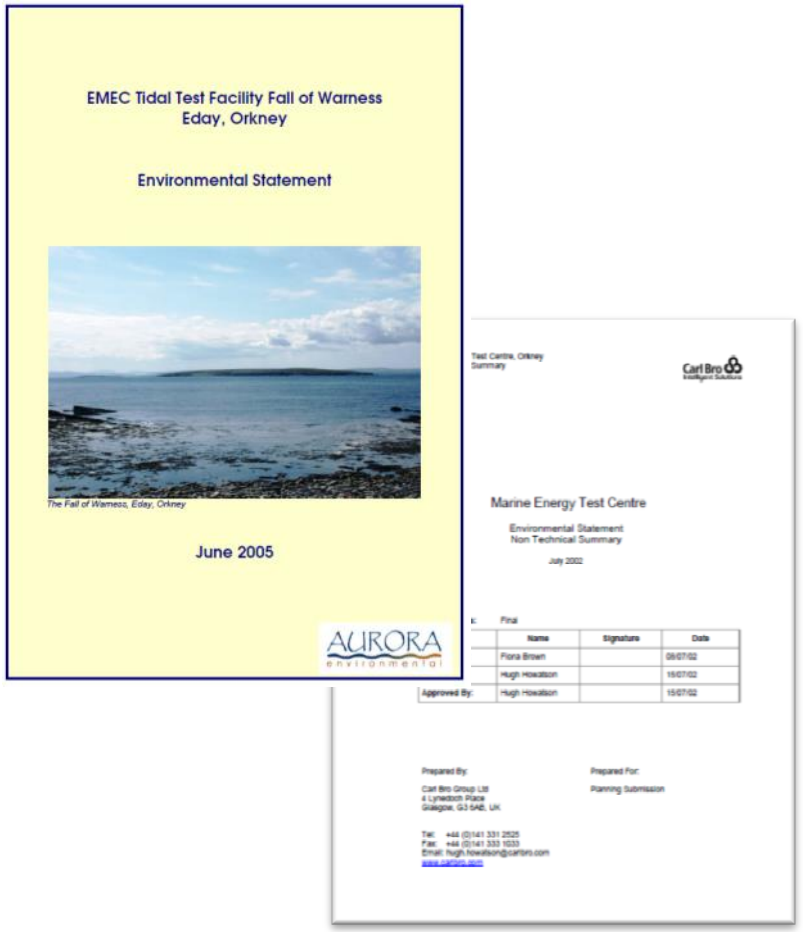


Marine Licensing at EMEC:
Regulatory Approach and Challenges

Jennifer Norris
Research Director

Starting point

- Establish framework for licensing
  - Site-wide or individual device licences?
  - Possible exemption from some legislation?
- EMEC – EIA for infrastructure and general activities & risks



Licensing process at EMEC full scale sites

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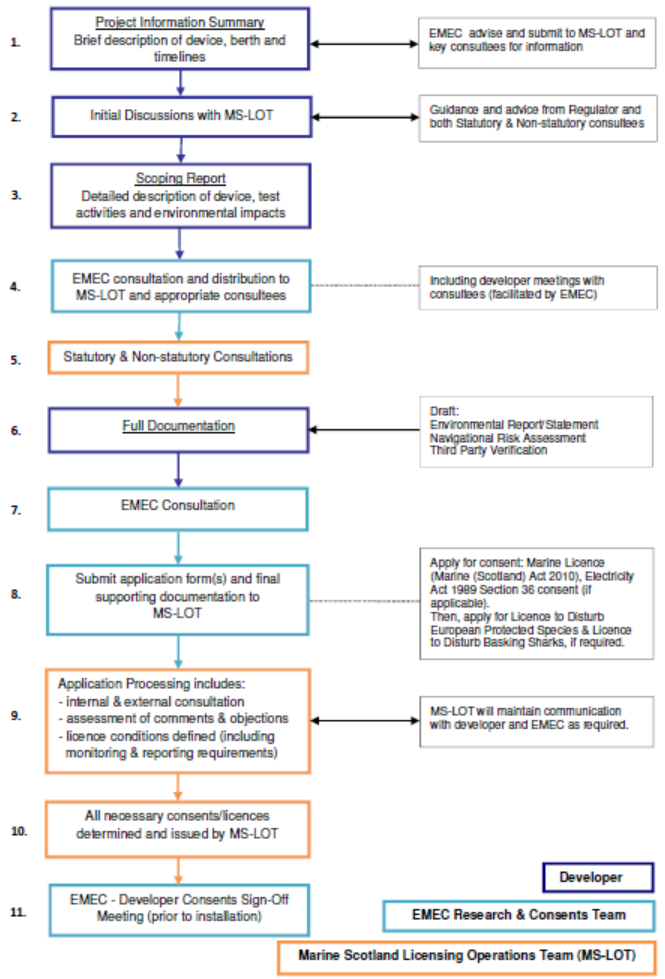
Developers apply for own individual licences

Device-specific documents:

- Scoping report
- Environmental Risk Assessment
  - Including Monitoring and Mitigation Plan
- Navigational Risk Assessment
- Third Party Verification
- Decommissioning Plan



Simplifying the process further

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Update EMEC Site Description Documentation:

- EMEC Site Navigational Risk Assessment
  - regular vessel traffic surveys
- Environmental Description
  - include all common (generic) elements and risks
  - include species presence
  - acknowledgement of sensitivities (species)
  - EU Habitats Regulations Assessment for site usage
  - specify issues for which monitoring is needed
- Site-wide licence for the site?
  - Would build on the site-wide licence for scale sites

Licensing process at EMEC scale sites

- EMEC holds the site licence
- ‘Envelope’ description of device features and maxima
- EU environmental risk assessment undertaken for future site usage
- Environmental monitoring can be centralised – more efficient
- Faster, more efficient route for testing

Assessing unknown (environmental) risks

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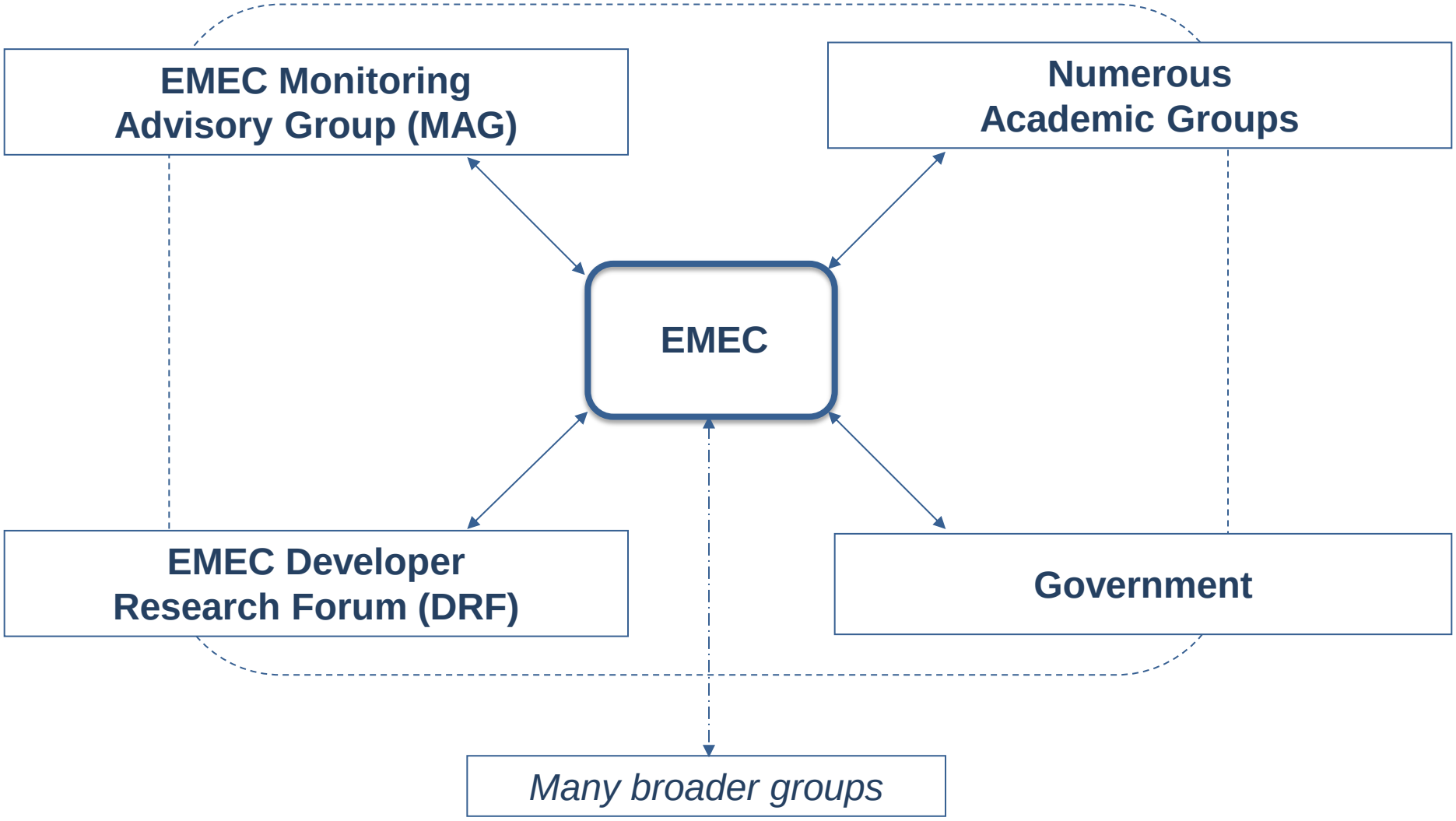
- Developers must address relevant risks in their documentation
- Some risks are unknown – introduces many challenges
- Identify ways of informing those issues (e.g. ‘deploy and monitor’ at early stages)
- Liaise with Regulators, their consultees, and other Stakeholders about potential risks
- Liaise with developers to understand constraints on their projects

Key liaison groups



Gathering the necessary information

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- Knowledge gaps identified
- Develop specific project plans
  - Observations / monitoring at sites
  - Targeted research projects
  - In close liaison with Regulators and targeted Stakeholders
- Obtain necessary funding
- Support from developer community
- Initiate projects

Key unknowns at EMEC: 1

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1. Collision

Potential for physical interactions (collision, causing harm or displacement) between marine wildlife and underwater moving parts of turbines

- Especially marine mammals, diving birds

Key unknowns at EMEC: 2

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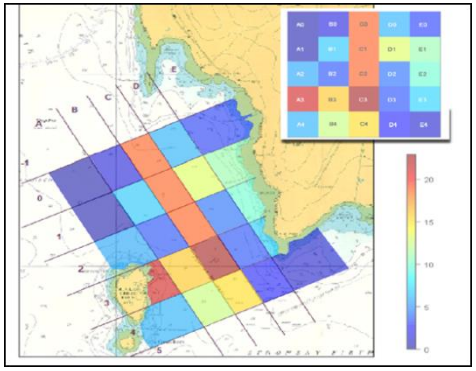
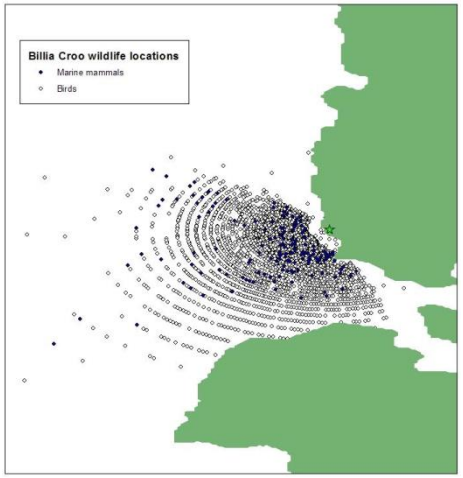
2. Displacement

Potential for marine wildlife displacement from habitual waters

- Especially marine mammals, diving birds





Key unknowns at EMEC: 3

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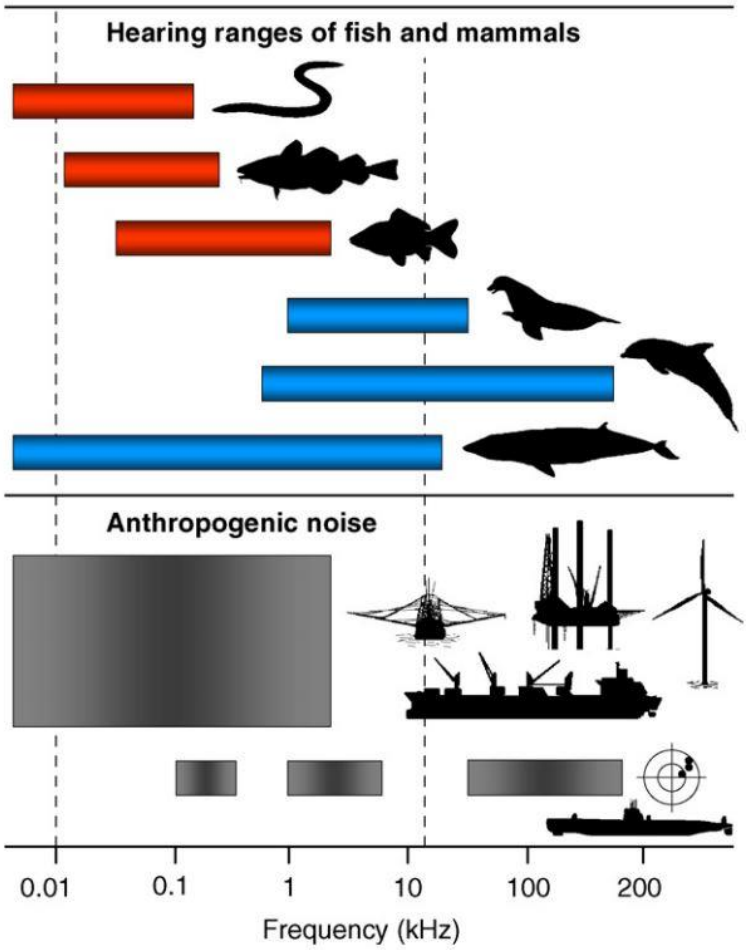
3. Noise emissions

Potential for harmful effects on wildlife of noise emitted underwater by installation and operation of devices

- Displacement
- Physical harm (hearing disruption)



Key unknowns at EMEC: 4

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4. Navigational safety

- Marking devices in strong tides
- Under-keel clearance
- Safe co-operative use of the seas

Key unknowns at EMEC: 5

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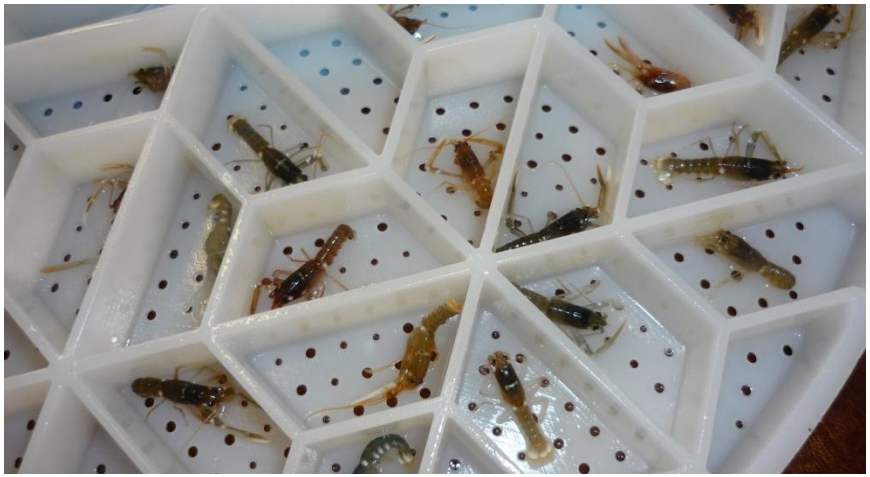
5. Effects on leisure and commercial activities

- Interactions between crustacea (lobster and crab) and devices
- Fisheries project at Billia Croo wave site

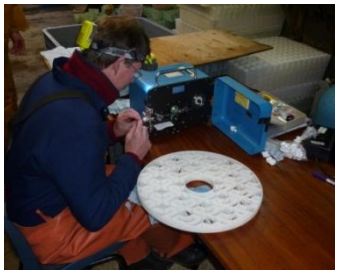


Billia Croo fisheries project

TEN YEARS OF MARINE ENERGY EXPERIENCE

Juvenile rearing

Tagging juveniles



Tag Injector

Discs with stage 8's

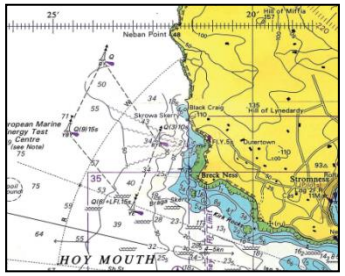
Discs loaded for release

Releasing juveniles

Undersize tagging

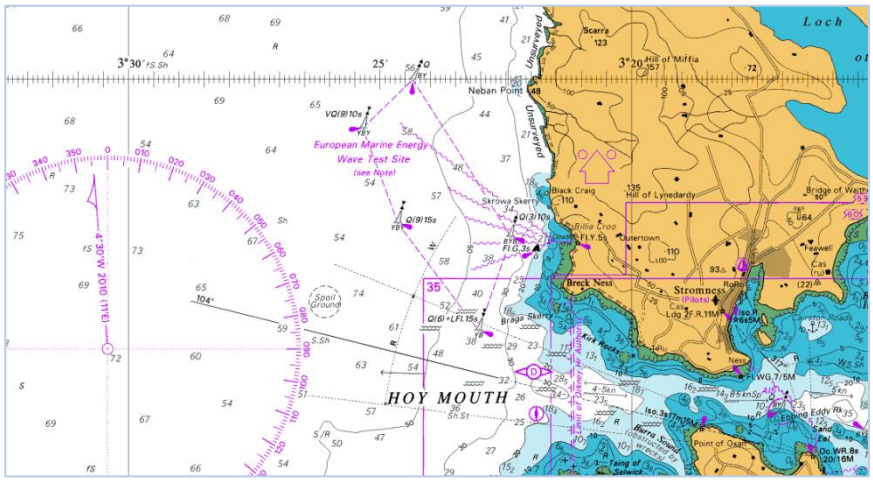
Full size logging

Survey area



Monitoring strategy

- Use learning from projects to integrate approaches and findings into site-wide monitoring strategies
- Keep projects current and relevant to Regulatory and Industry needs
- Disseminate project outputs to:
  - Regulatory authorities & advisors
  - Developer / industry community



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Thank you

Follow us on:

Jennifer Norris

EMEC Research & Consents

Marine Licensing and Consents

Jim McKie

Marine Scotland, Marine Laboratory, Aberdeen

This presentation will provide information on the following;

- Licensing and consenting process in Scotland
- Streamlining at EMEC
- Future – more streamlining

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Consents and Licences Required in Scotland

- Marine Scotland Act and Marine and Coastal access Act
- Section 36 of the Electricity Act 1989 (s.36)
- Section 44 European Protected Species (EPS)
- Town and Country Planning (Scotland) Act
- Energy Act (2004) Decommissioning – UK Govt
- Full EIA required and HRA required where LSE is identified

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Marine Scotland – Licensing Operations Team

- MS-LOT 31 staff
- Renewable and non-renewable applications
- Marine Licence Applications and Section 36 consents
  - S36 consents for renewable developments
    - Over 1MW within 12nm
    - Over 50 MW out with 12nm
- Environmental Impact Assessment (EIA) required for many of our projects
  - Environmental Statement is the product of EIA
- Small projects do not require EIA, only Marine Licence Application and supporting documents (This case!)

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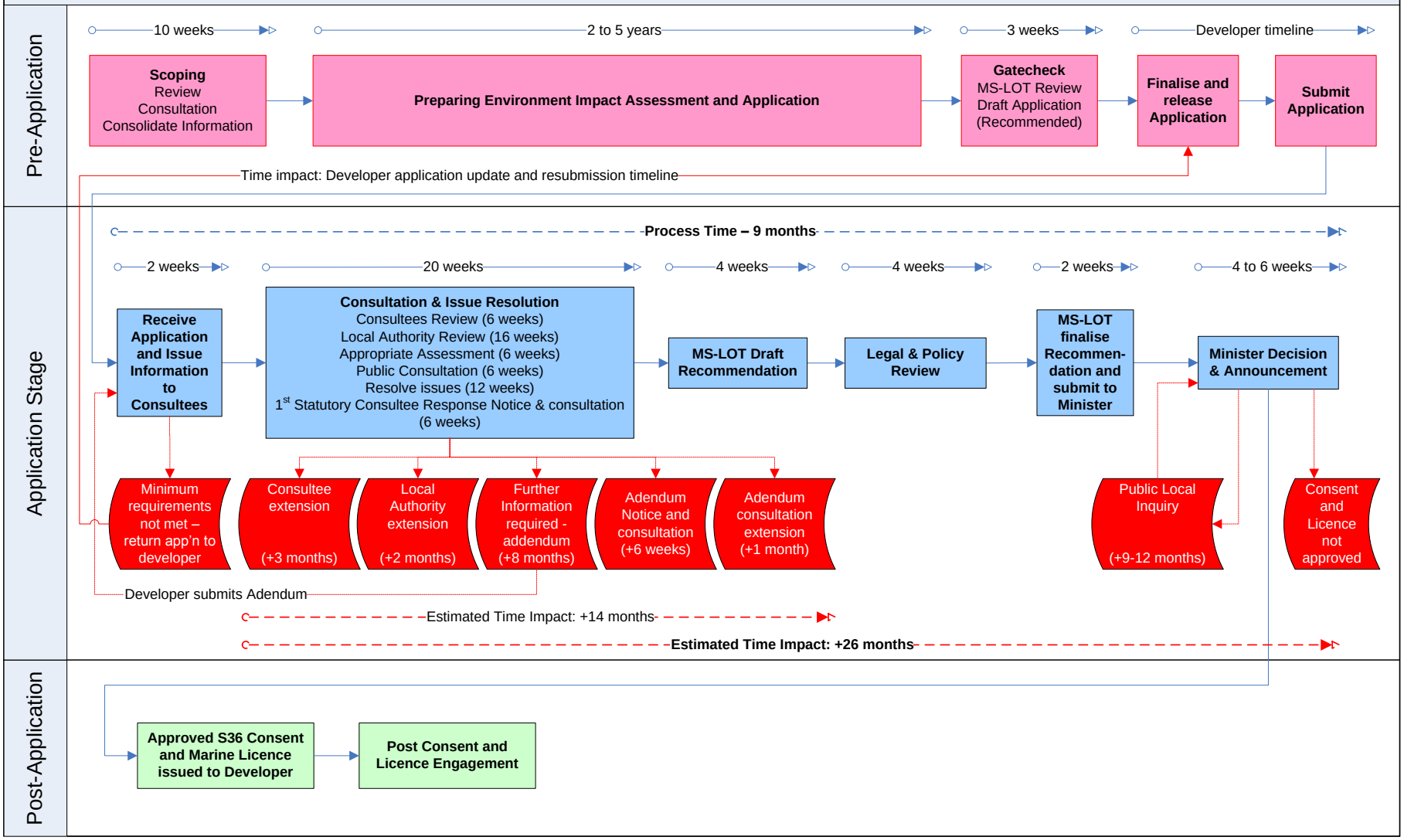
EIA PROCESS POTENTIAL TIME IMPACTS

4 Dec 2012



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“Good News”

- Originally each developer had to apply for a licence from MS-LOT on their own merits with supporting information
- This was found to be resource intensive and disproportionate as the environmental conditions on the sites are fairly uniform
- Solution
- Step away from single applications to site wide licences with an envelope of consent

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“First Trial”

- At the two scale sites (Shapinsay Sound and Scapa Flow) we consented an envelope of devices
- The assessment of this considered the “worst case devices” that could be deployed at the sites
- MS-LOT undertook an Appropriate Assessment of this envelope

- Result

- Reduction from 12 weeks to 7 days to get approval to deposit a device at either site providing it fits within the preapproved envelope.

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“Moving Forward”

- Scottish Natural Heritage have begun drafting an environmental assessment of the Fall of Warness (FoW) - main tidal site

- This will asses all environmental factors associated with deploying a device (within a specifically consented envelope) at the FoW

- Some documentation will still have to be submitted and consulted on [e.g. Navigational Risk Assessment, Project Environmental Monitoring Programme (PEMP)]

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“The Future”

- Result of this
  - MS-LOT aim to reduce consenting time from 12 weeks to 5 weeks to get approval and licence to deposit a device providing it is within the preapproved envelope
  - MS-LOT aim to deliver this by Christmas 2013
- What about the future? Site wide section 36 consents allowing the testing of devices above 1 MW?

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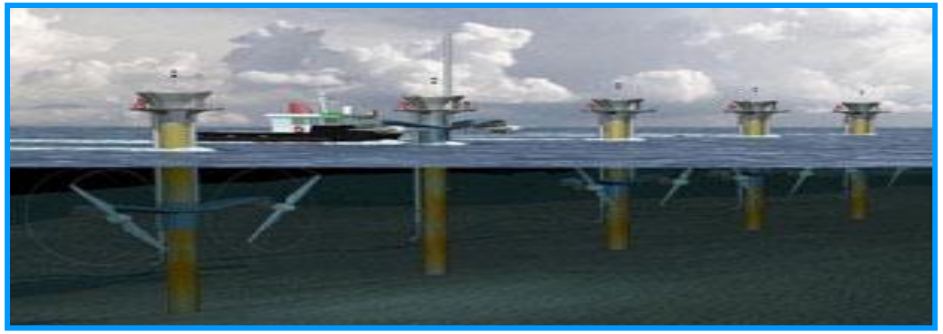
Conclusions

- Streamlining the licensing/consenting reduced the burden and facilitates industry to progress towards meeting the SG targets for 2020.
- Implemented streamlined licensing at EMEC
- Good results from first streamlining exercises
- Facilitating discussions on future streamlining
- Information: http://www.scotland.gov.uk/Topics/marine/Licensing/marine and http://www.scotland.gov.uk/Topics/marine/science/MSInteractive



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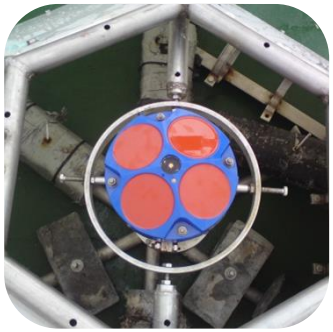
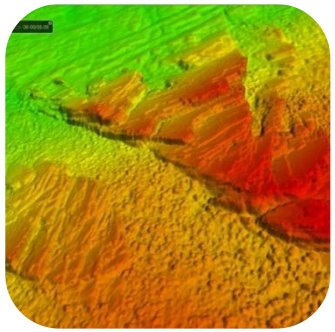
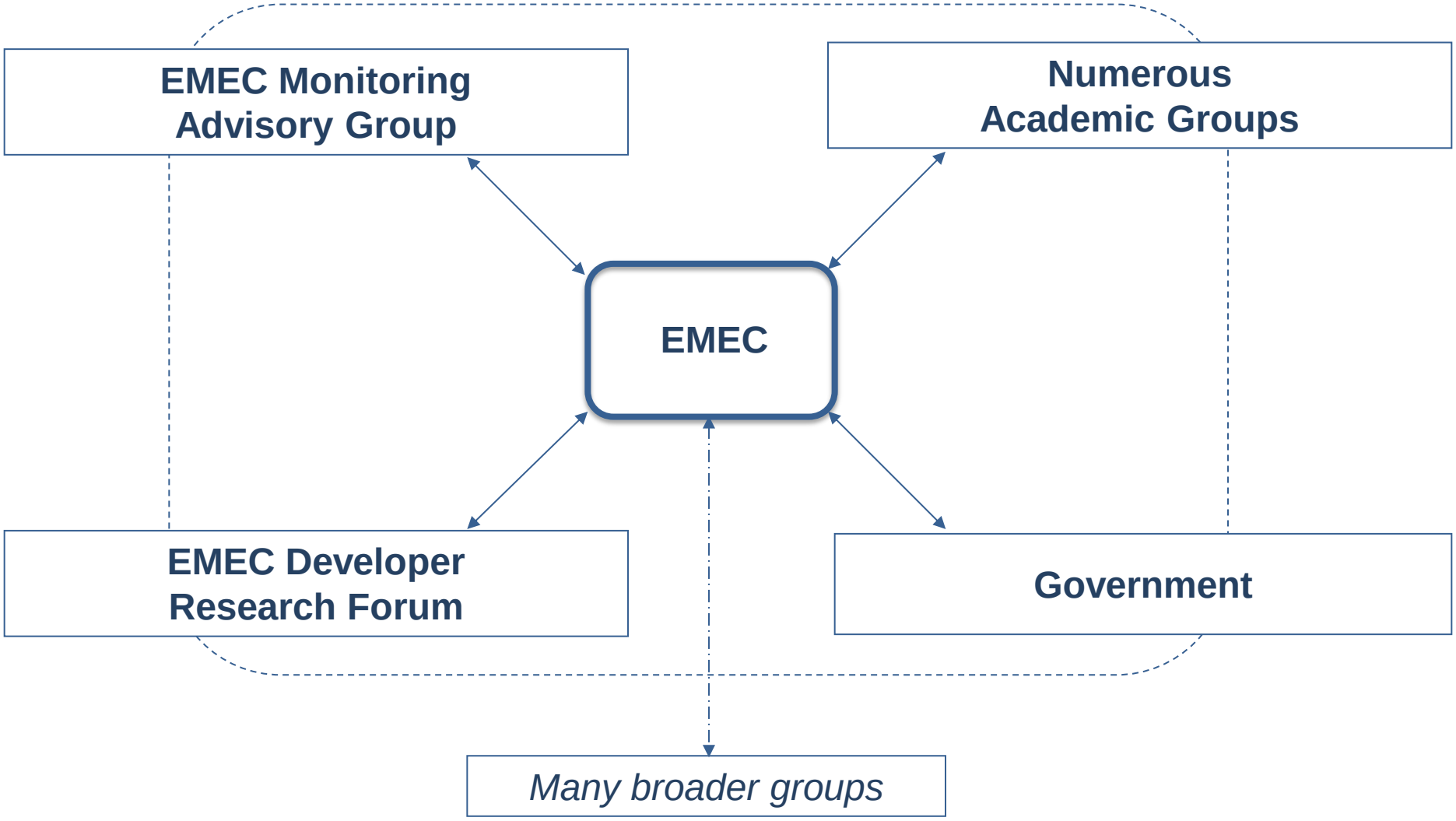



Research Opportunities

Matthew Finn
Research Coordinator

Research drivers



Research areas

- Device and system generators
- Equipment and components
- Guidelines and standards
- Tool development
- Infrastructure and enablers

Research areas

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- **Device and system generators** – **Performance data collection**
- Equipment and components – **1st generation device trials**
- Guidelines and standards – **2nd generation device trials**
- Tool development – **2nd generation array trials**
- Infrastructure and enablers – **Components and materials**
- *Installation methods*
- *Recovery methods*
- *Low cost O&M techniques*

Research areas

EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE

- Device and system generators
- **Equipment and components**
- Guidelines and standards
- Tool development
- Infrastructure and enablers

- **Sensors**
- **Offshore connectors**
- *Control systems*
- *Power electronics*
- *Generators*
- *Device structure*
- *Foundations and moorings*
- *New component development*

Research areas

EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE

- Device and system generators
- Equipment and components
- **Guidelines and standards**
- Tool development
- Infrastructure and enablers

www.emec.org.uk/standards

- **Design**
- **Manufacture & assembly**
- **Health and safety**
- **Certification**
- **Testing**
- **Performance**
- **Resource assessment**
- **Environmental**

Research areas

EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE

- Device and system generators
- Equipment and components
- Guidelines and standards
- **Tool development**
- Infrastructure and enablers

- **Environmental monitoring**
- **Resource analysis**
- **Site assessment**
- *Condition monitoring*
- *Device modelling*
- *Array design and modelling*
- *Techno-economic tools*
- *Failure mode modelling*
- *Reliability modelling*

Research areas

EMEC 10
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- Device and system generators
- Equipment and components
- Guidelines and standards
- Tool development
- **Infrastructure and enablers**

- **Site licensing**
- **Knowledge transfer networks**
- **Skills and training**
- **Supply chain development**
- **Marine testing facilities**
- **Long term market support**
- **Energy Storage**
- *Offshore grid*
- *Tank testing facilities*

Summary

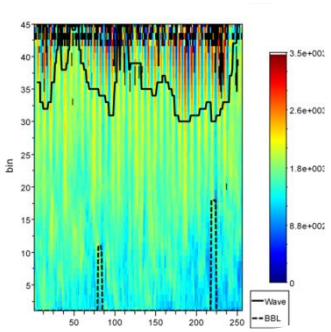
EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE

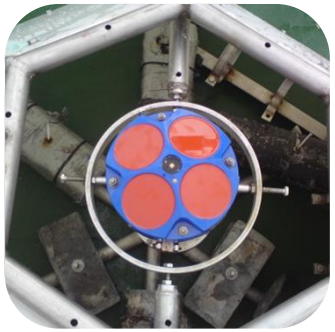
1. We prioritise industry-focused research
2. EMEC is a key resource - make use of it
3. Independent and well connected – we welcome your ideas for collaborative projects

A GLOBAL CENTRE OF EXCELLENCE IN
MARINE ENERGY TESTING AND RESEARCH

EMEC
TEN YEARS OF MARINE ENERGY EXPERIENCE





Case Study 1:
Resource Assessment

Dr John Lawrence
Hydrodynamicist

Resource assessment

EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE

Site Properties:

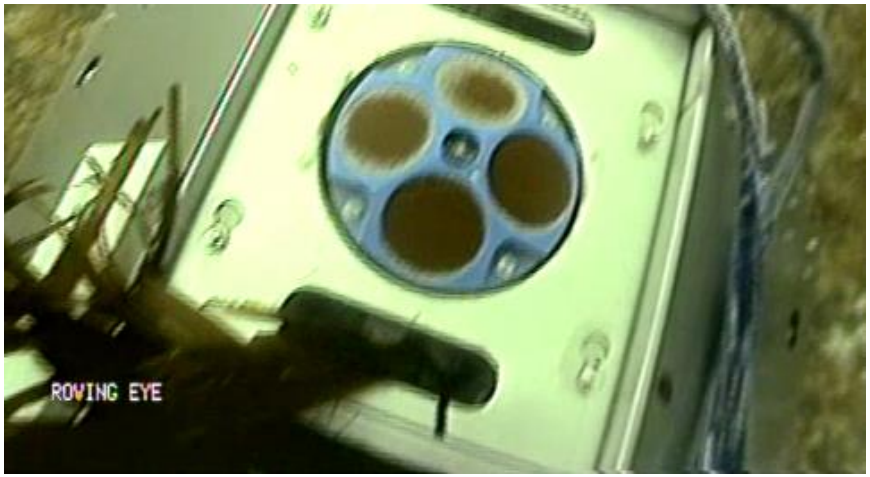
- Resource level
- Resource quality
- Device survivability

Tidal resource assessment

EMEC
TEN YEARS OF MARINE ENERGY EXPERIENCE

Tidal Site:

- Main equipment in use:
  - Acoustic profilers
  - Marine radar
- Spot deployments
- Long term deployments
- Weather station



Tidal resource assessment

EMEC
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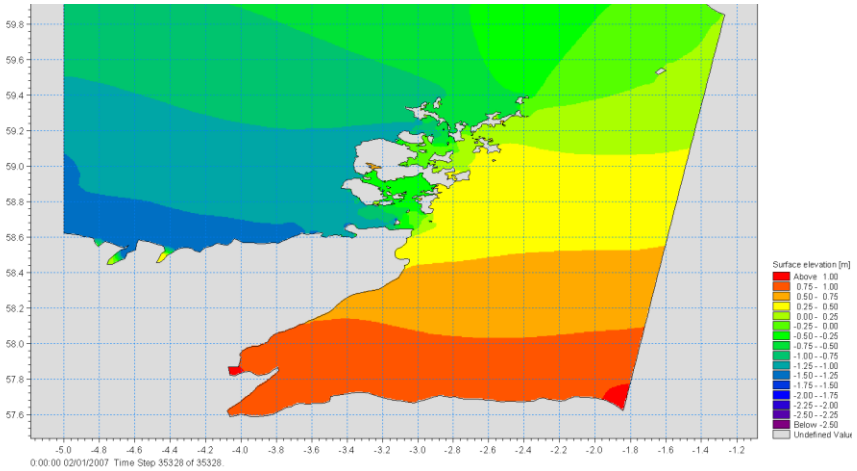
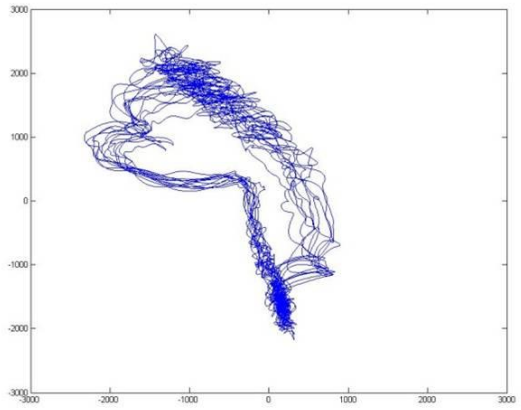
Tidal data:

- Hydrodynamic models
  - 2D regional flow model
  - 3D model of the Fall of Warness
  - Wave current interaction
- Berth selection
- Site variability
- Turbulence





Wave resource assessment

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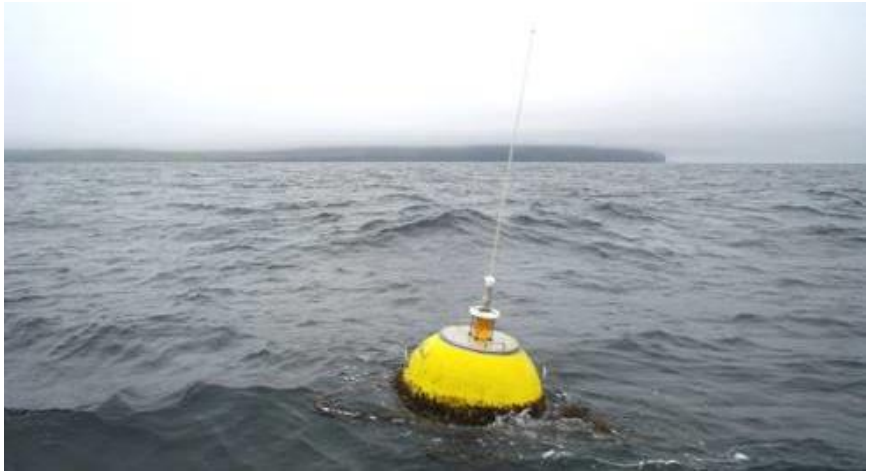
Wave Site:

- Wave data since 2002
- Waverider buoys
- Wave radar
- Weather station
- Acoustic profilers

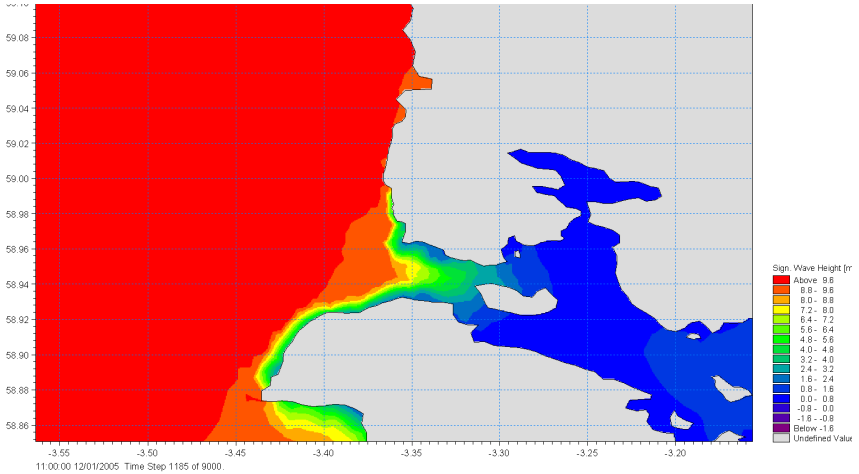


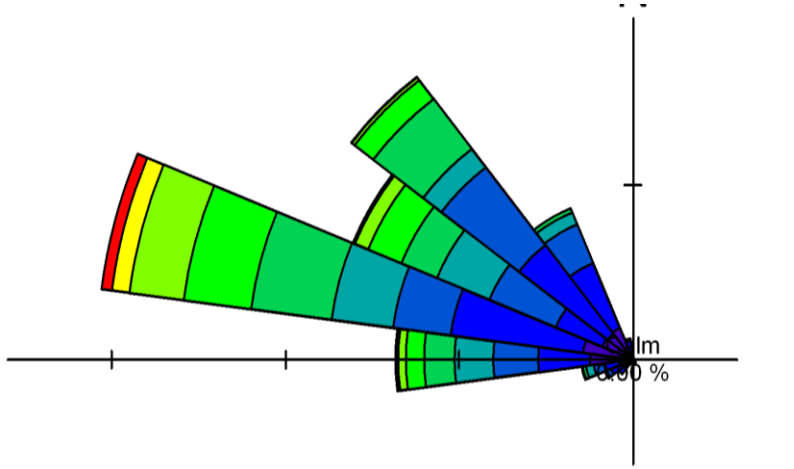
Wave resource assessment

EMEC
TEN YEARS OF MARINE ENERGY EXPERIENCE

Wave data:

- Site variability
- Storm studies
- Regional wave model – 20years
- Forecasting model
- Berth selection





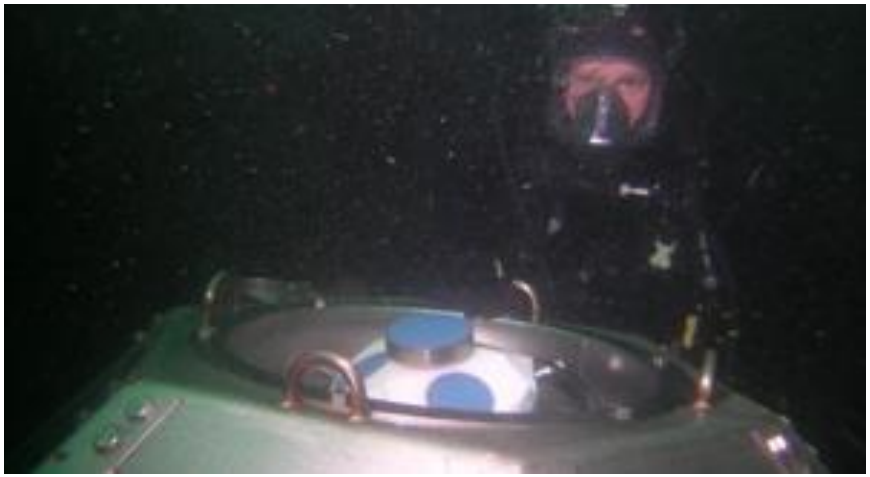
Resource assessment

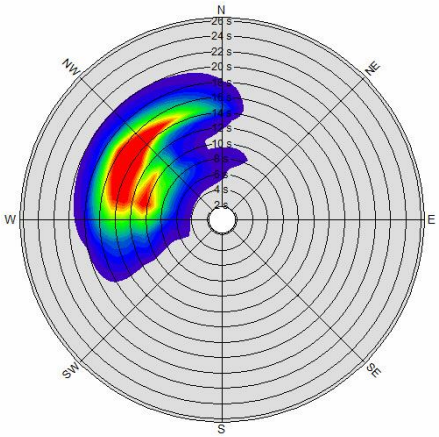
EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE

Active research areas:

1. Data collection techniques
2. Measurement platforms
3. Equipment trials
4. Data analysis
5. Method repeatability

    - IEC TC114 & MaRINET





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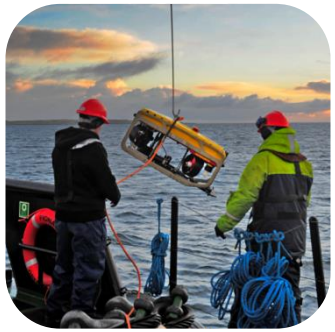
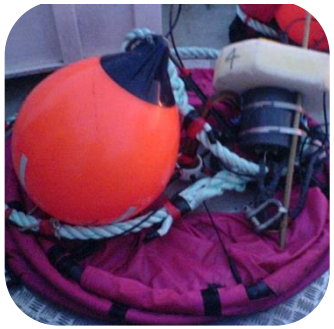
EMEC
TEN YEARS OF MARINE ENERGY EXPERIENCE




Case Study 2:
Integrated Environmental Monitoring

David Cowan
Research & Consents Manager

Integrated environmental monitoring

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TEN YEARS OF MARINE ENERGY EXPERIENCE

Main driver:

- uncertainties captured in the regulatory process

Key environmental uncertainties:

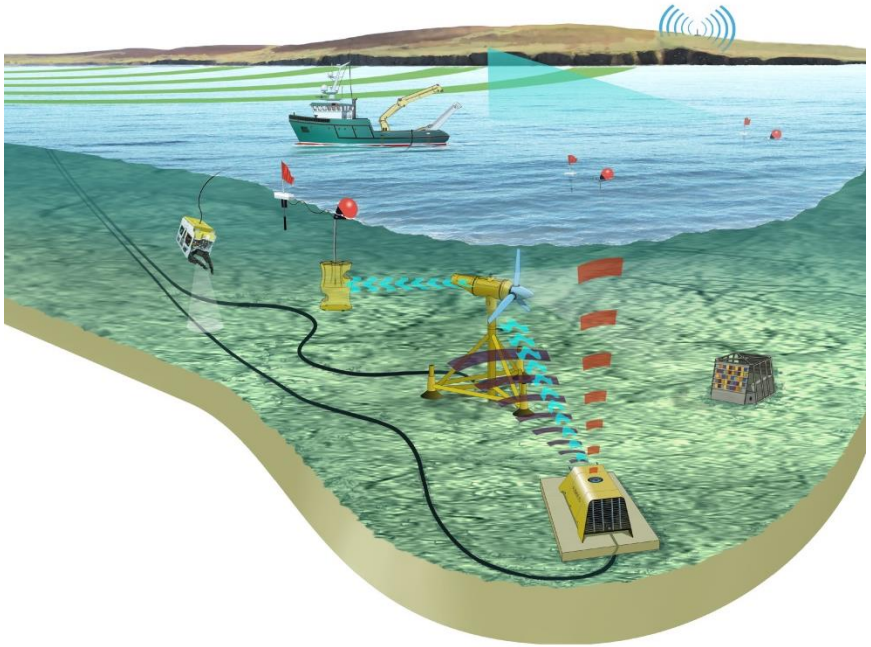
- Collision;
- Underwater Noise;
- Displacement

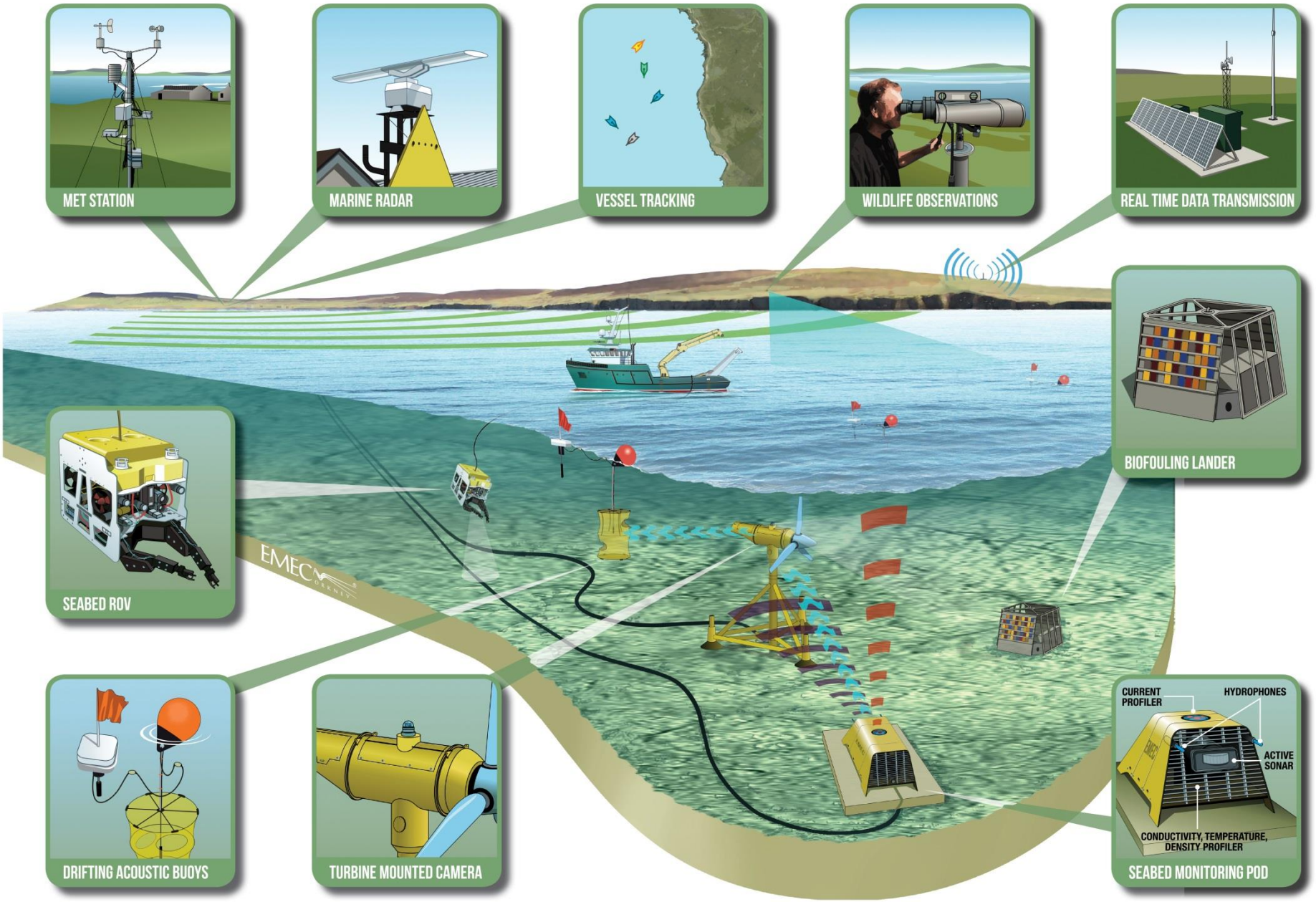
Challenge:

- Complex issue in a complex environment

Solution:

- Integrated approach using a variety of complimentary measurement streams





A GLOBAL CENTRE OF EXCELLENCE IN
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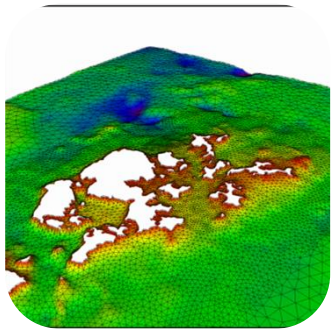
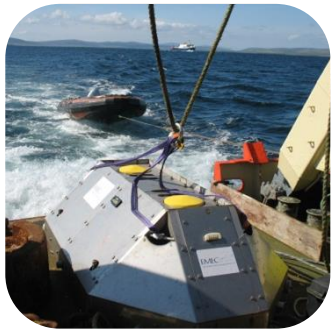
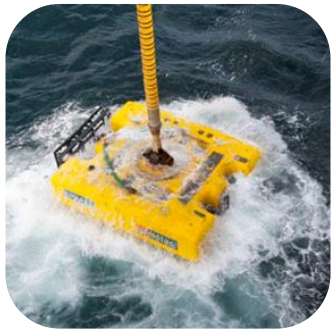
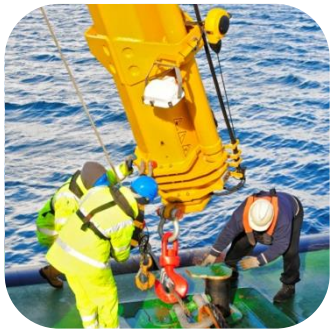


Thank you

A GLOBAL CENTRE OF EXCELLENCE IN
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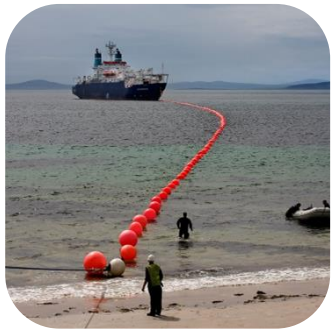
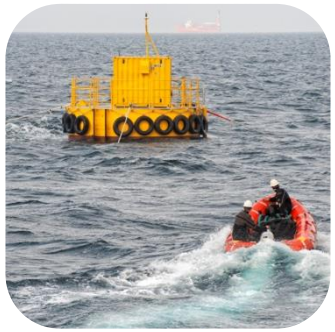




EMEC Operations

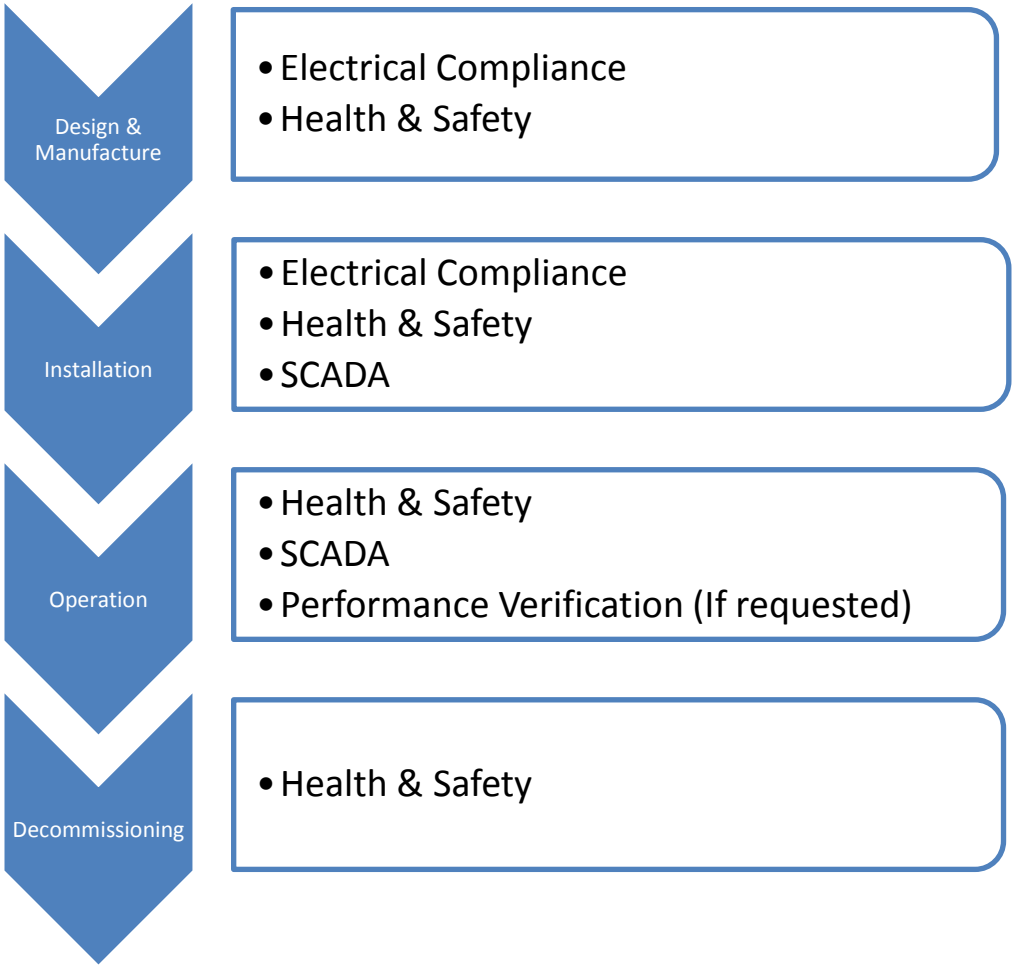
Stuart Baird
Operations Director

Operations Team

EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE

- Maintenance of Site Infrastructure
- Comms, IT & SCADA
- Test Environment
- Health & Safety

Lifecycle



Achievements

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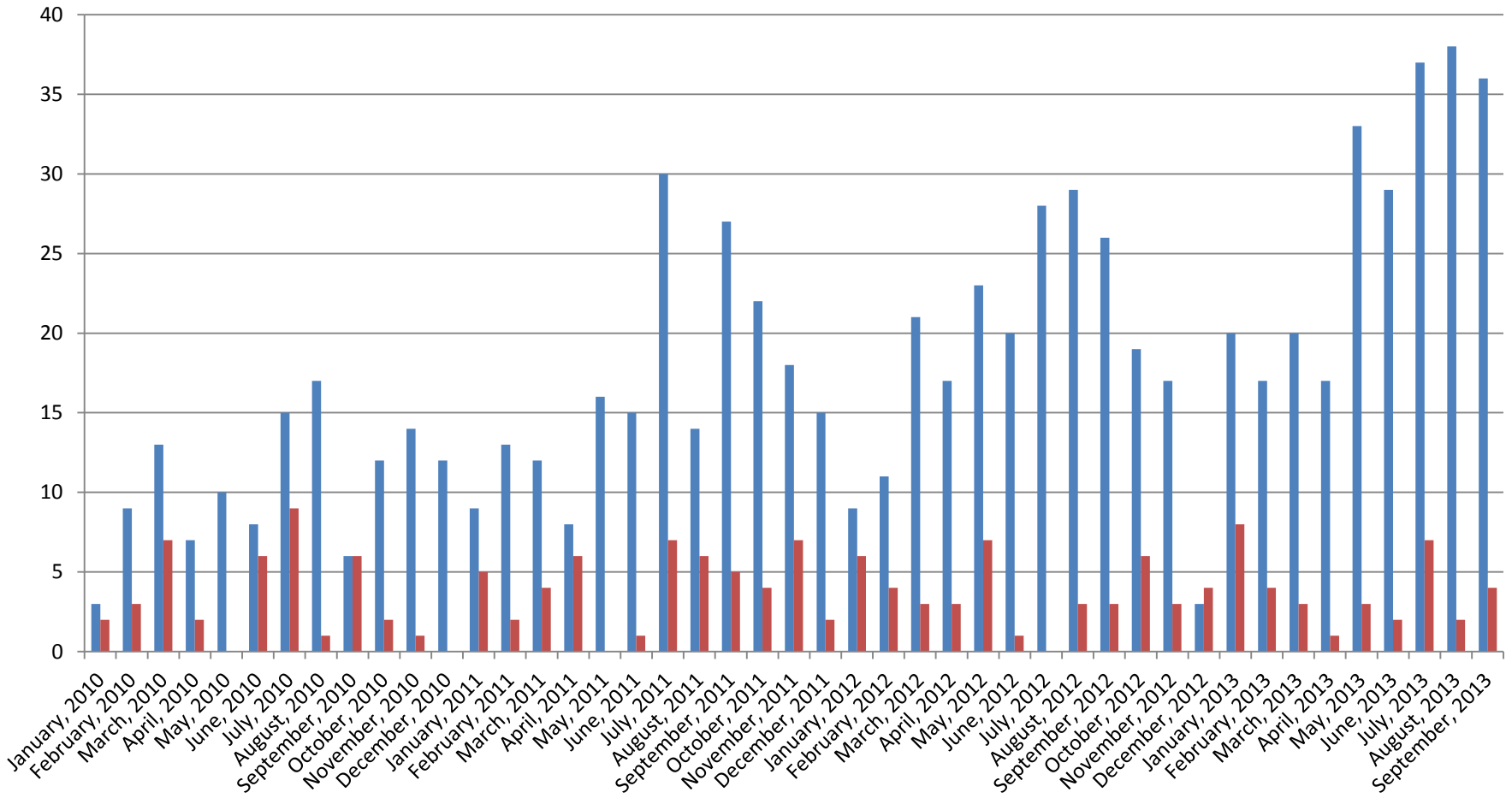
- Added new cables
- Fitted new cable ends
- Designed & Commissioned Scale Test Sites
- Upgrades to facilities

Site Permits



Site Vessel Operations

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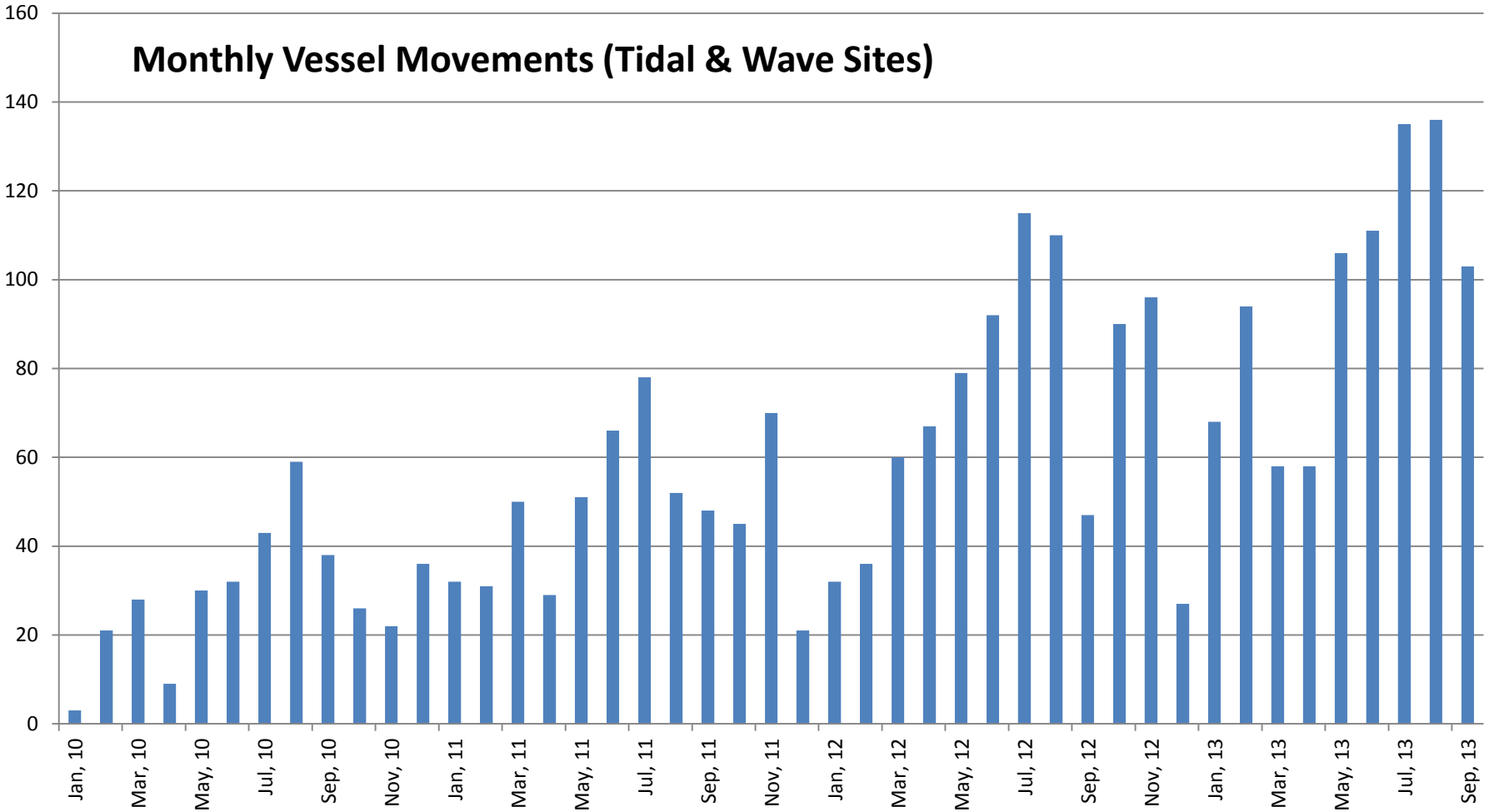

Just another day…..

EMEC
TEN YEARS OF MARINE ENERGY EXPERIENCE

Onsite Activity Report
Start date: Wednesday 28 August 2013

Area	Vessel	Time in		Time out	
Billia Croo	OCEAN ENTERPRISE	28-Aug-2013	08:34	28-Aug-2013	10:07
	VOE VIKING	28-Aug-2013	08:41	28-Aug-2013	15:23
	BLAZE	28-Aug-2013	08:44	28-Aug-2013	09:11
Fall of Warness	ORCADIA	28-Aug-2013	06:18	28-Aug-2013	08:39
	S.R.TWO	28-Aug-2013	06:35	28-Aug-2013	12:59
	EARL SIGURD	28-Aug-2013	07:11	28-Aug-2013	17:40
	GREEN ISLE	28-Aug-2013	07:35	28-Aug-2013	23:59
	C-ODYSSEY	28-Aug-2013	07:38	28-Aug-2013	23:59
	OCEAN EXPLORER	28-Aug-2013	07:58	28-Aug-2013	17:26
	USKMOOR	28-Aug-2013	08:14	28-Aug-2013	23:55
	GM700	28-Aug-2013	08:27	28-Aug-2013	23:57
	OPENHYDRO ORAISTE	28-Aug-2013	09:16	28-Aug-2013	16:16
	C-SALVOR	28-Aug-2013	11:23	28-Aug-2013	23:59
	KARIN	28-Aug-2013	11:43	28-Aug-2013	21:55
	CAPELLA	28-Aug-2013	12:55	28-Aug-2013	18:20
	SUBSEA VIKING	28-Aug-2013	18:08	28-Aug-2013	18:16








Just another day…..

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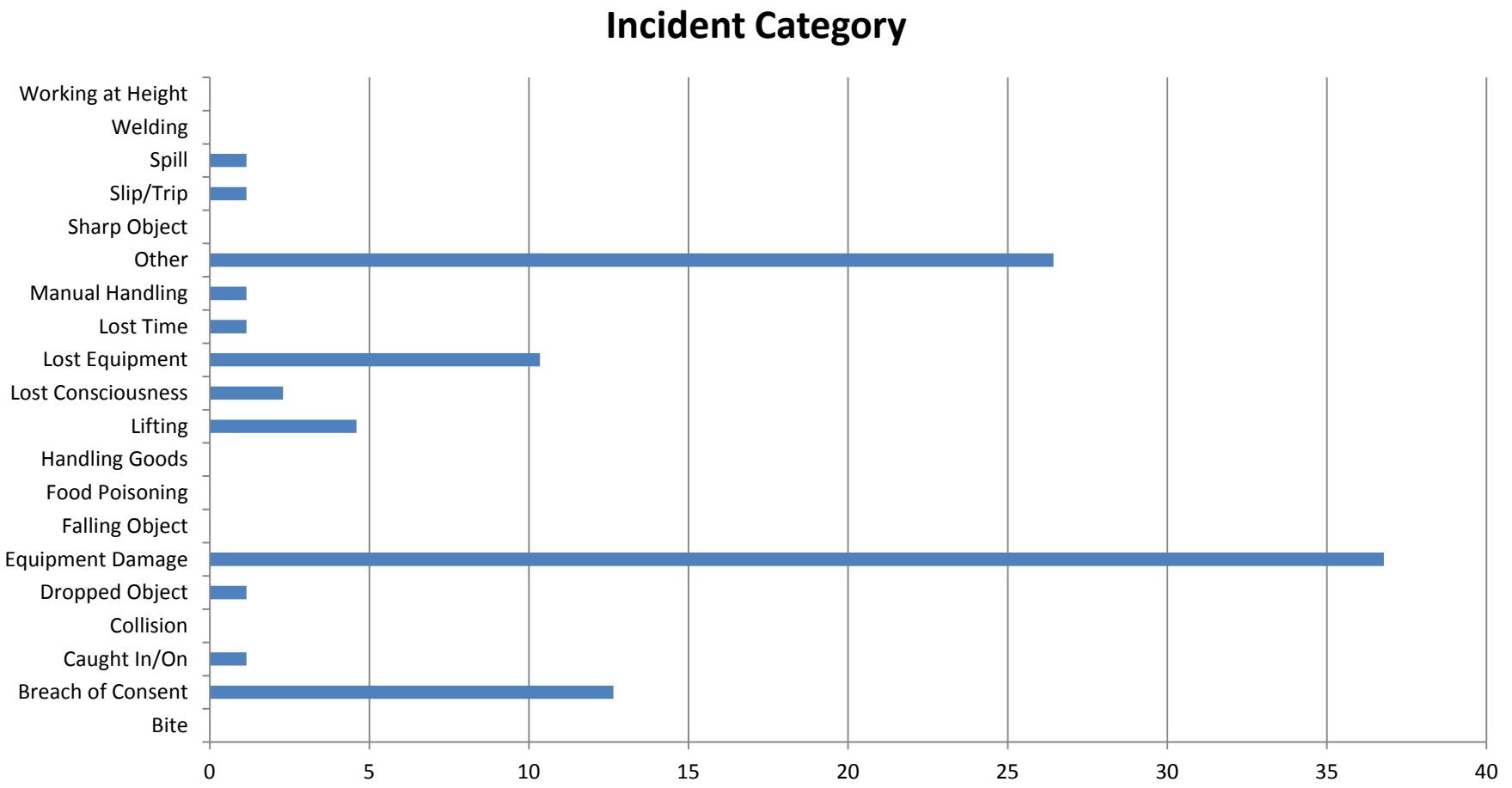
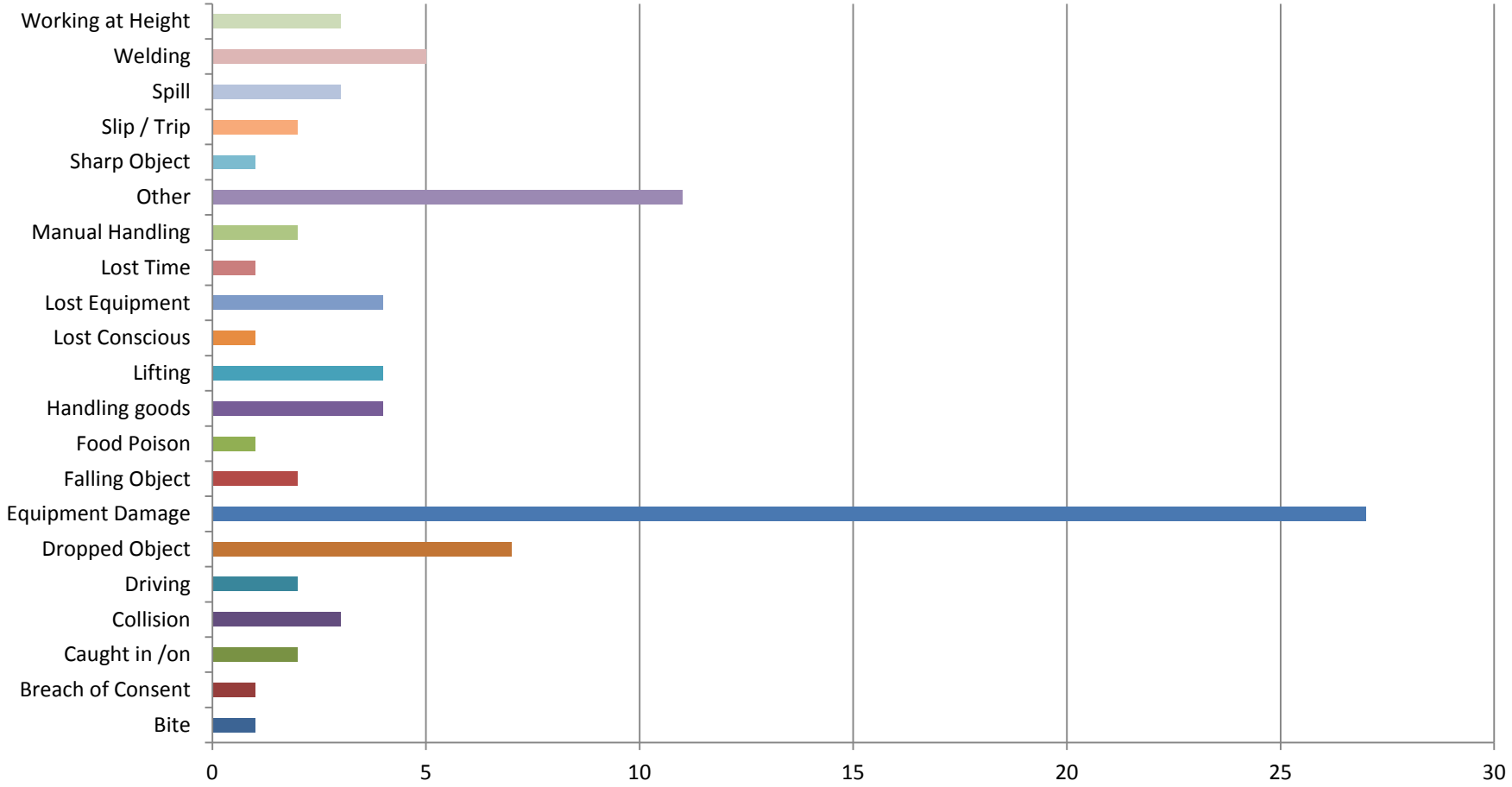
TEN YEARS OF MARINE ENERGY EXPERIENCE

EMEC H&S Statistics

TEN YEARS OF MARINE ENERGY EXPERIENCE



TCE Wind Farm H&S



Energetic environments

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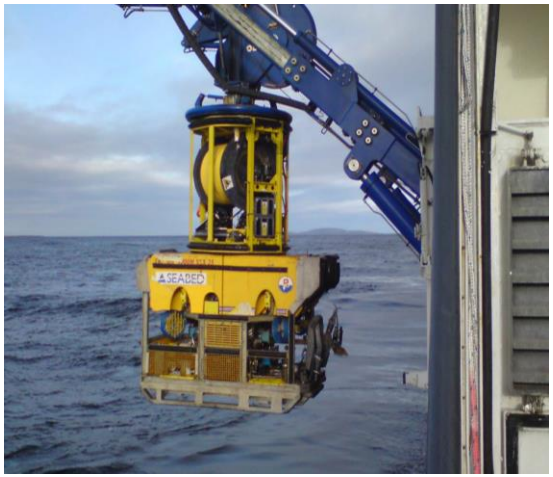

Pod deployment

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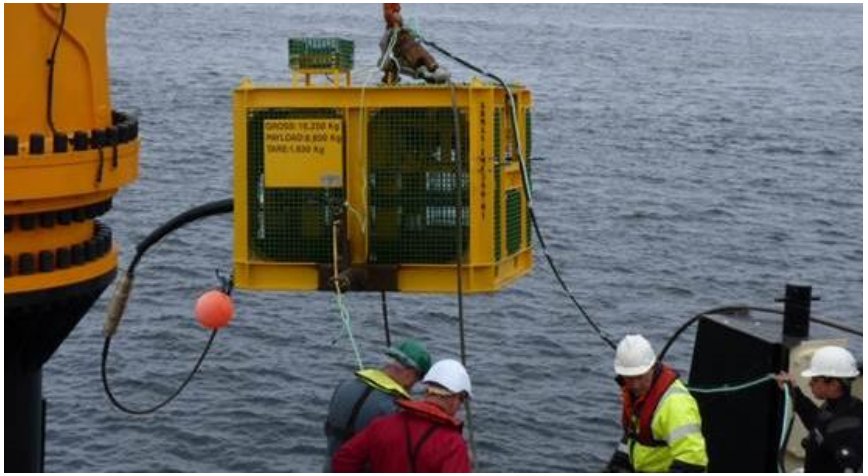
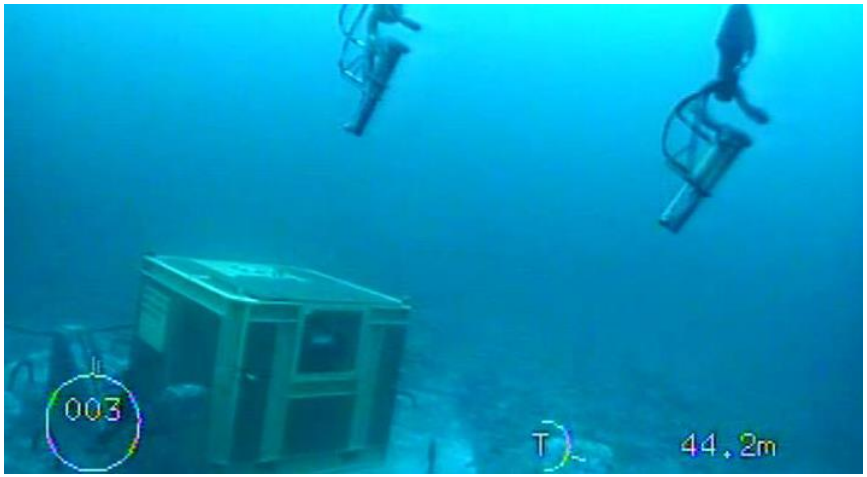
TEN YEARS OF MARINE ENERGY EXPERIENCE





Drifting Ears

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TEN YEARS OF MARINE ENERGY EXPERIENCE

Drifting Ears

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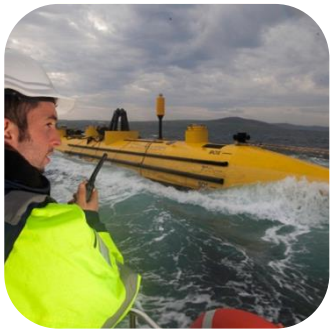




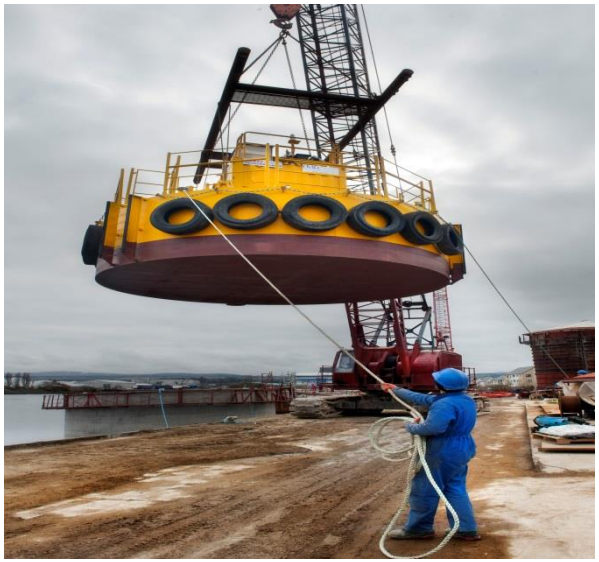
Thank you

Follow us on:

Stuart Baird

EMEC Operations

The Impact of Wave and Tidal to The Crown Estate



Alexis George
Health and Safety Manager
Energy and Infrastructure

Scope

- The Crown Estate
- The E&I Portfolio
- How we work
- The future – Wave and Tidal
- Planning for increasing presence and emerging technologies

The Crown Estate

Landowner established in 1760, comprising all the land owned by the King. Public body (The Crown Estate Act 1961) acting as a commercial enterprise – but not part of UK Government.

Owner of the seabed around the UK.

Owner of approximately half the foreshore and coastline of the UK.

Assets £8.1 billion.

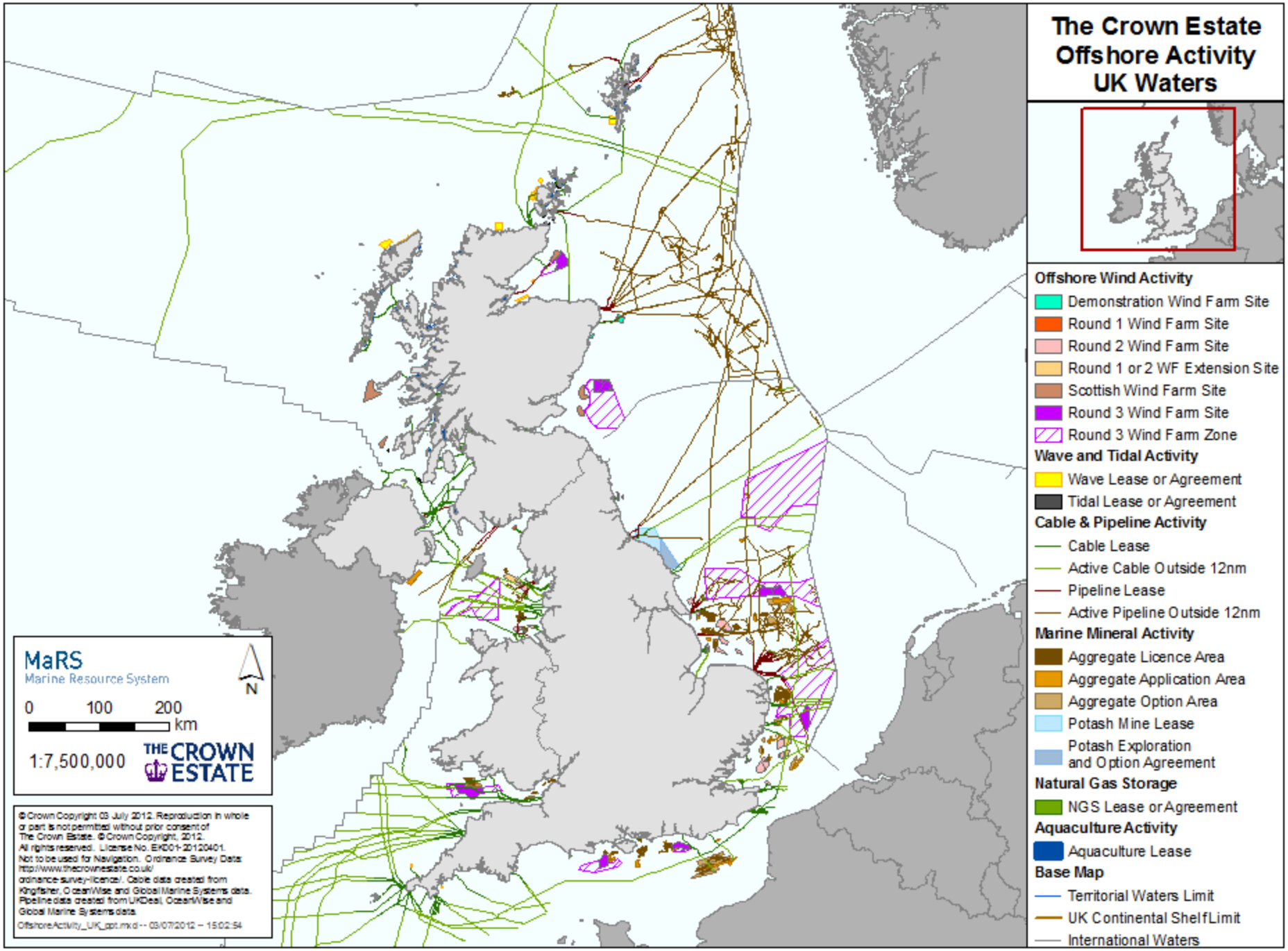
Four separate “portfolios” of property.

Urban

Rural

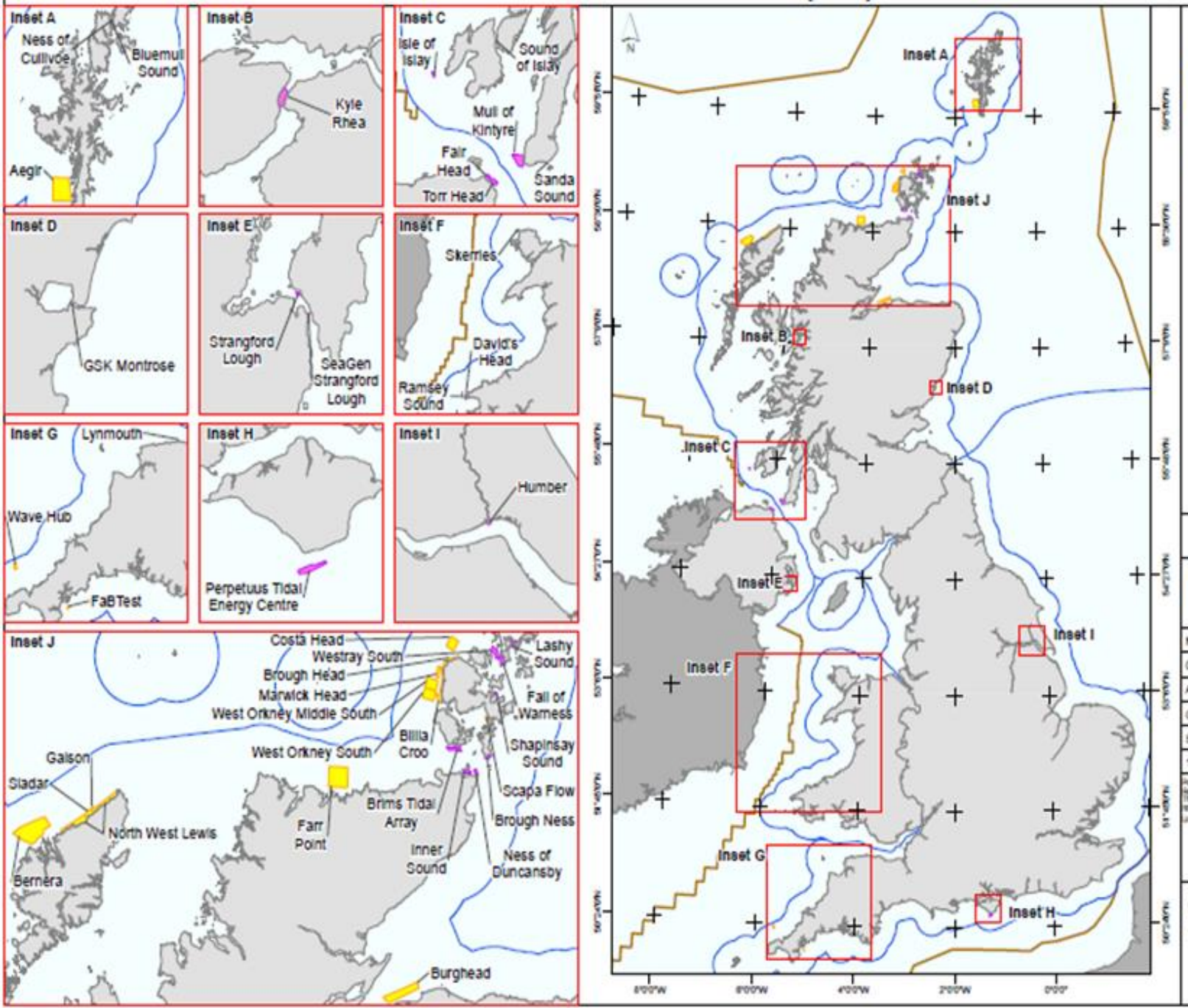
Estates

Energy and Infrastructure

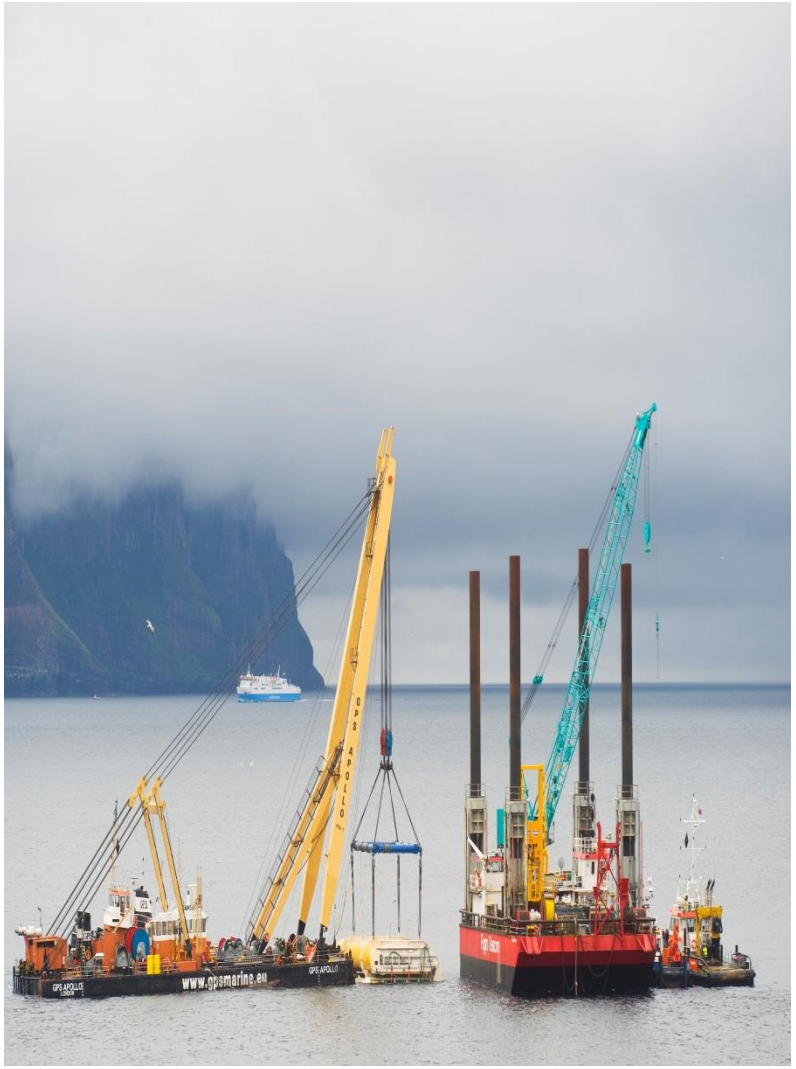


OffshoreActivity_UK_opt.mxd -- 03/07/2012 -- 15:02:54

Wave and Tidal (UK)



How do we work?



- Landlord – lease seabed through leasing rounds
- Co-investment in development
- Facilitator and advisor – working closely with Industry and Government

The Future – Wave & Tidal

Increase in distance and size

- Diving operations – adequate hyperbaric environments
- Personnel transfer
- Competency and training (and adequate supervision)
- Search and Rescue capabilities
- Communication and leadership
- First Aid resource availability and suitable training
- Welfare capabilities
- Availability of fit for purpose vessels


HS 019


COASTGUARD
RESCUE

Photo from EMEC courtesy of Mike Brookes-Roper


P2-001
e·on
pelamiswave.com


SEVERNSEA


Photo from EMEC courtesy of Mike Brookes-Roper
FIONA F.
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VOITH

Planning …

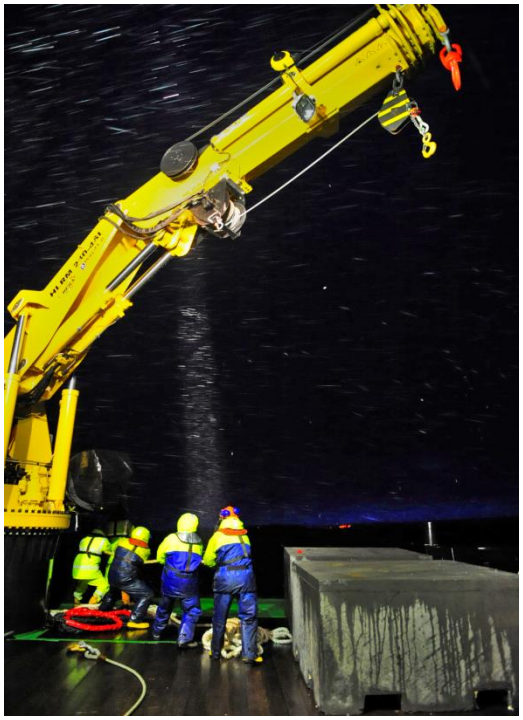
… For increasing presence and emerging technologies

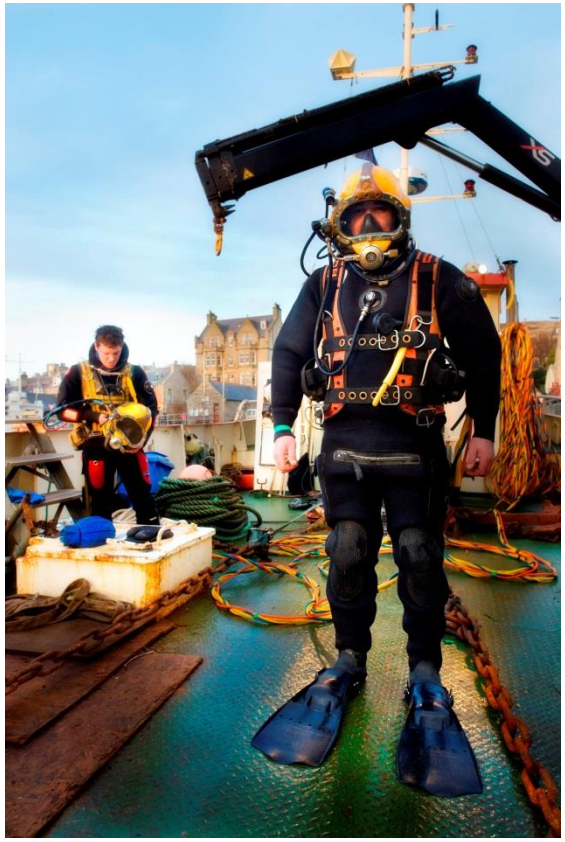
- Safe by Design
- Vessel Construction Safety Guide
- Health and Safety Award

Safe by Design

- What and Why?

- TCE will be hosting its first Wave, Wind and Tidal workshop on 27th November 2013.
- Fundamental topics





All Photos from EMEC courtesy of Mike Brookes-Roper

Health and Safety Workstreams

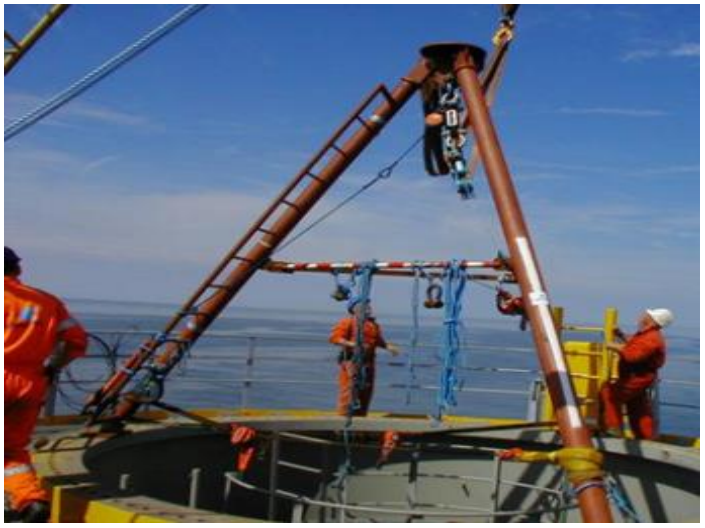
THE CROWN ESTATE

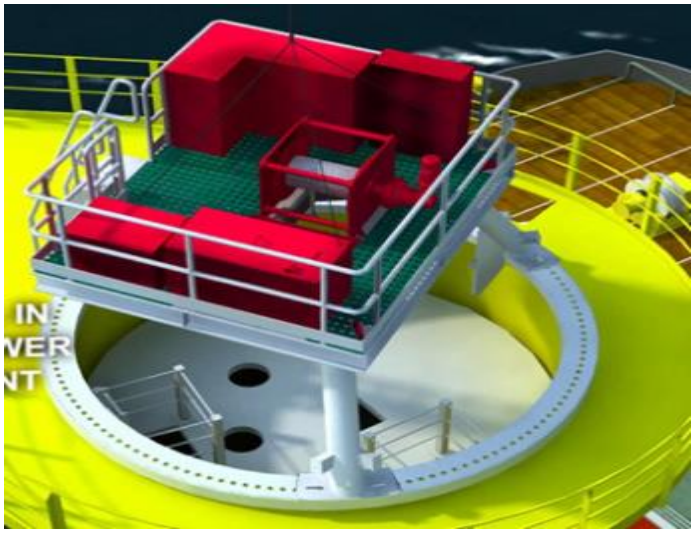
Vessel Construction Safety Guide

- Wave, Wind and Tidal developments is a relatively new and rapidly growing business working in deep waters and in hostile wave and tidal environments
- The intention to provide guidance in the process, selection and management of vessels and to ensure all are ‘Fit for Purpose’ and operated within a diligent Health & Safety culture.
- Working in conjunction with the Energy Institute and the G9 Group.
- The aim is for publication early 2014.

Health and Safety Award

- The Crown Estate sponsor the Health and Safety award in conjunction with Renewable UK, now in its 3rd year
- Encourages sharing of best practice
- Applications from single companies, projects/JV's and any business working in the renewable energy
- Excellent rewards in the past 2 years going to EON and last year to Technip Ltd.
- The 2014 Renewable Energy Health & Safety Award will be presented on the eve of conference reception on the 28th January 2014 in Birmingham.





Summary

The Crown Estate is becoming more recognised across the offshore wind industry as leaders and facilitators in Health and Safety.

"Our vision is to demonstrate leadership and support within the Energy and Infrastructure sectors that The Crown Estate operates in, setting high standards, promoting best practice while delivering and maintaining optimal performance. Working with our tenants and industry partners The Crown Estate will assist in developing and promoting solutions that result in improved industry Health, Safety and Environmental performance and in doing so secure the sustainability of The Crown Estate's business in the future".

Alexis George

Health and Safety Manager
Energy and Infrastructure
The Crown Estate

Alexis.george@thecrownestate.co.uk

A GLOBAL CENTRE OF EXCELLENCE IN
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TEN YEARS OF MARINE ENERGY EXPERIENCE





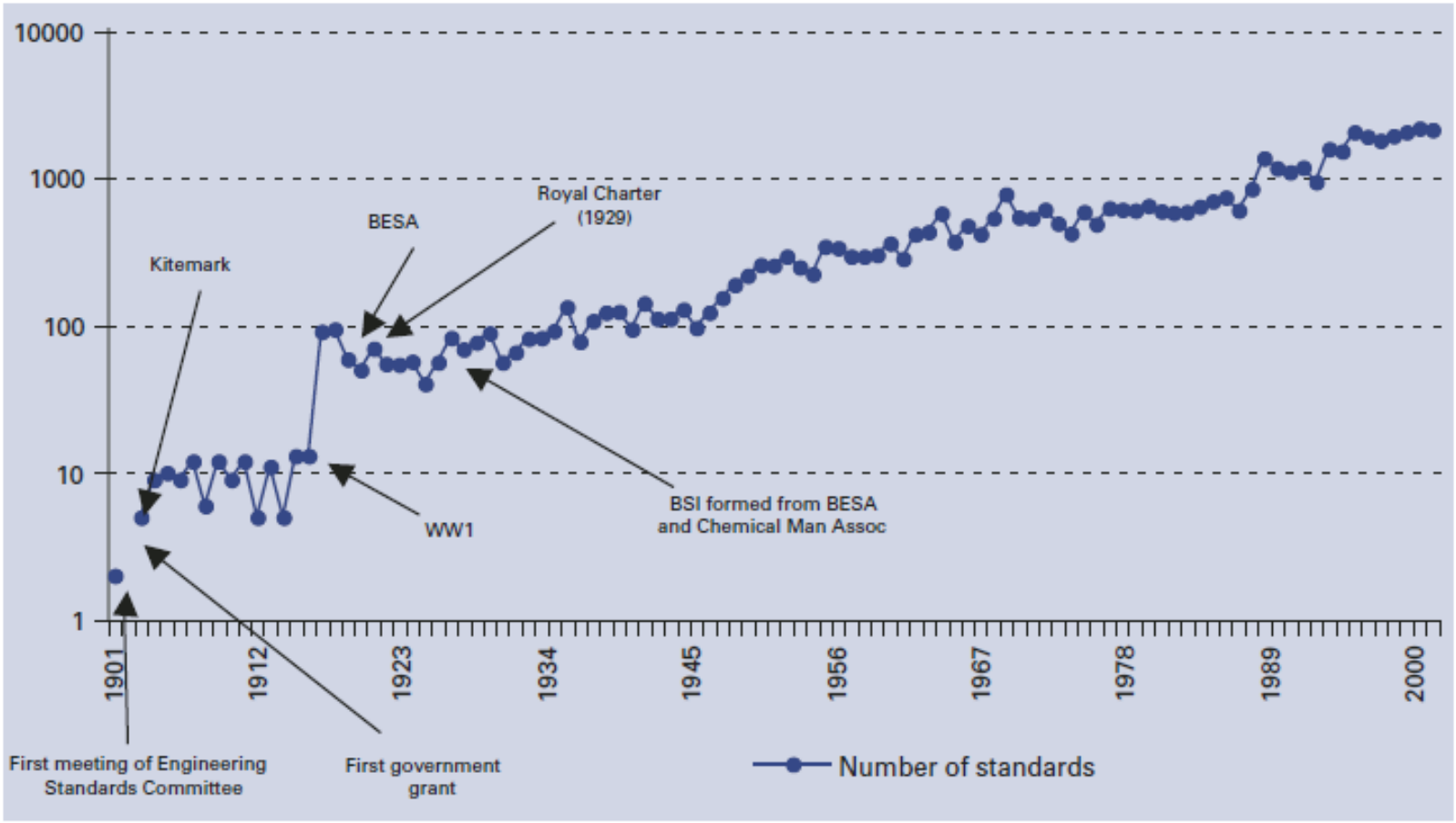
Why International Standards?

John Griffiths
Technical Director
(Chairman of UK National Committee on
Ocean Energy Standards PEL/114)

Standards grow with technology

EMEC TEN YEARS OF MARINE ENERGY EXPERIENCE

(Source: BSIPERINORM)



Exponential Growth in Technology = Exponential Growth in standards

Successful industries...

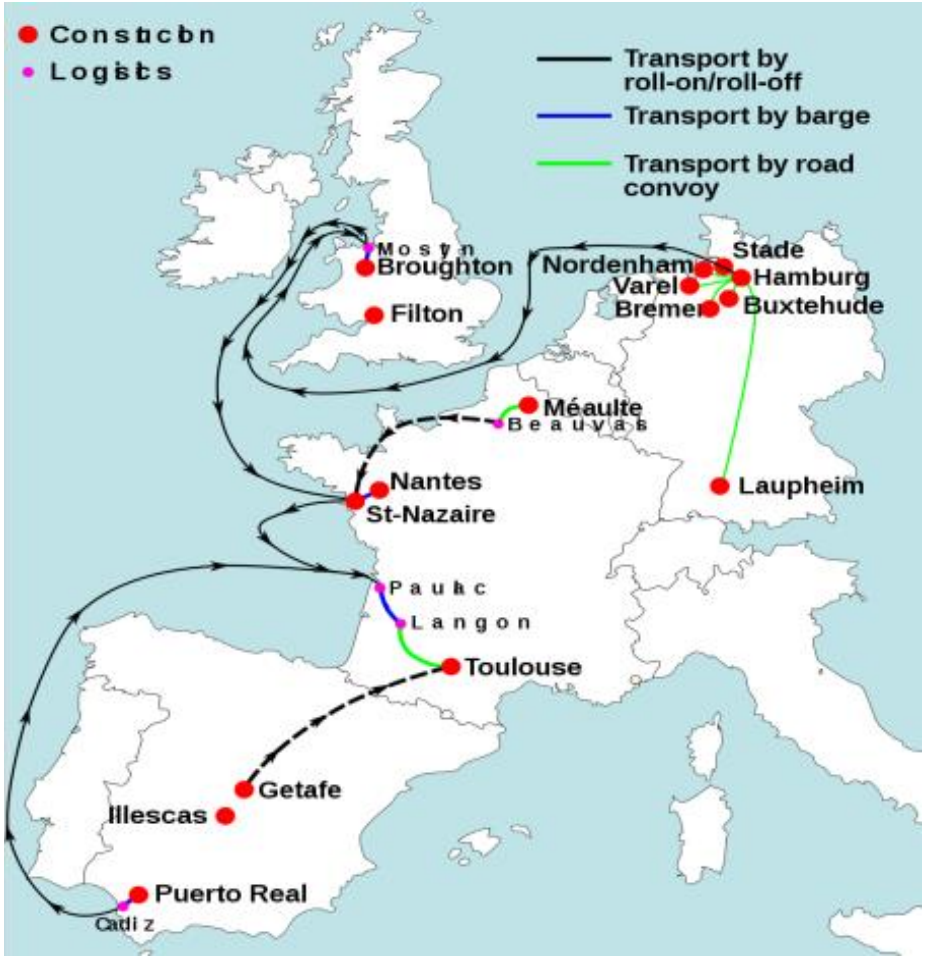
… ARE HIGHLY STANDARDISED!

27,000 active standards:

- Automotive
  - 400 standards
- Aerospace
  - 800 standards

Complexity creates need for Standards

- AIRBUS aircraft are assembled in Toulouse and Hamburg
- Wings in Filton & Broughton
- Fuselage/Cabin in Hamburg, Bremen & St Nazaire
- Tail assemblies at Hamburg, Stade, Getafe, Illescas & Puerto Real
- This could never be achieved without detailed standardisation



A Bit of History

EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE

2003: First draft standard - Wave Device Performance

2004: UK Government Wave & Tidal Protocols for Performance Measurement

2005: DNV Guidelines on Design and Operation of WECs

2007-9: EMEC draft standards and guidelines

2008-11: EquiMar Protocols and deliverables, EU project

2008 on-going: IEC International standards (Secretariat through BSI)

2012/13: First International Technical Specifications published

Myths and Arguments

EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE

1. Too early for Standards

- No: EMEC had to have standards to measure W&T resource and device performance
- No: The international marine energy industry needs to measure and understand resource on a common basis.

2. Standards will stifle innovation

- No: Aerospace and automotive industries constantly innovate yet depend on standards
- These industries are very commercial and highly successful.

Myths and Arguments

EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE

3. Standards will limit diversity in ocean energy

- No: US DoE lists 261 different wave and tidal technologies
- There are 8 types of WEC and 7 types of TEC plus hybrids – there is great diversity.

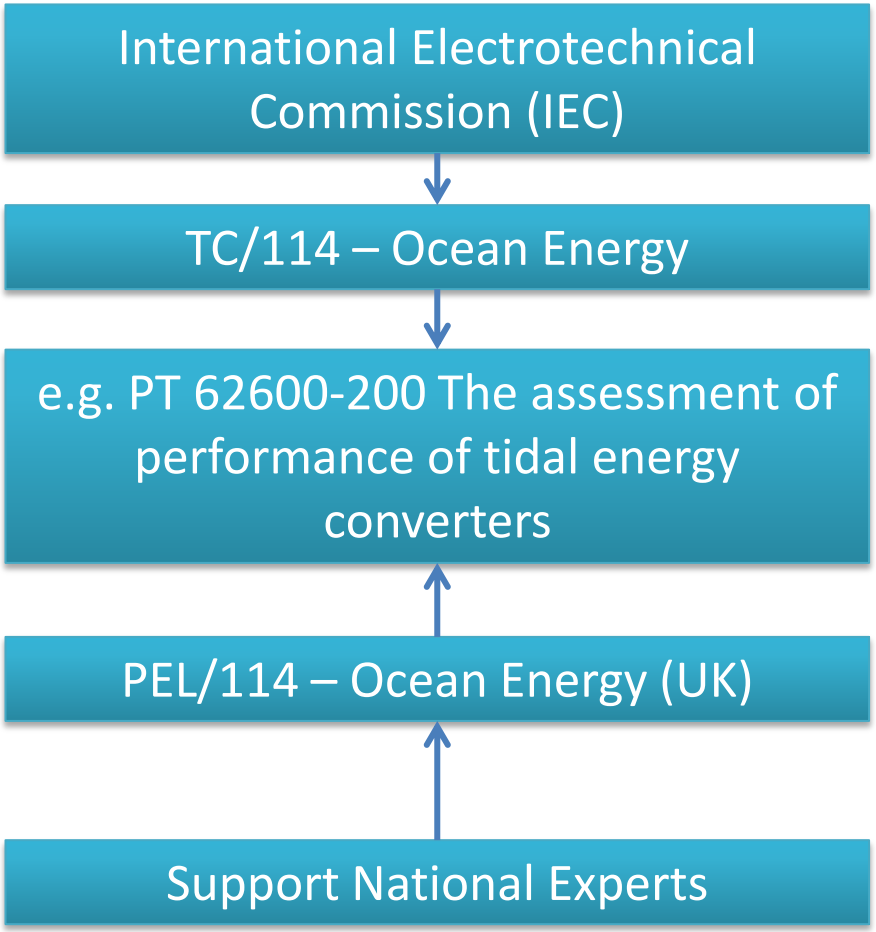
4. International agreement leads to lowest common denominator

- No: higher level definition accommodates varying views whilst retaining essential guidance
- Over-prescription is stifling and limiting to good design

Making of Standards – Structure

EMEC TEN YEARS OF MARINE ENERGY EXPERIENCE

- International Body
- Technical Committee
- Project Teams
  (draft standards)
- National Committee
  (nominate experts)
- Mirror Committees



International Committee TC-114

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TEN YEARS OF MARINE ENERGY EXPERIENCE

- **Three standards published:**
  - Terminology
  - WEC Test
  - TEC Test
- **8 international project teams:**
  - Design Requirements
  - Wave Energy Resource Assessment
  - Tidal Energy Resource Assessment
  - Assessment of Moorings Design
  - WEC Power Performance at Second Location
  - Power Quality
  - Tank Testing – Wave
  - Ocean Energy Thermal Conversion
- **Working Group – Certification & Compliance**

Member Nations of TC/114

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- All these nations are potential markets!
- All want to get involved

(P) Denotes Participating Members
(O) Denotes Observer Members

Country	Country Code	P/O Status
Brazil	BR	O-Member
Canada	CA	P-Member
China	CN	P-Member
Czech Republic	CZ	O-Member
Denmark	DK	P-Member
France	FR	P-Member
Germany	DE	P-Member
Ireland	IE	P-Member
Italy	IT	O-Member
Japan	JP	P-Member
Korea, Republic of	KR	P-Member
Netherlands	NL	P-Member
Norway	NO	P-Member
Poland	PL	O-Member
Portugal	PT	O-Member
Romania	RO	O-Member
Russian Federation	RU	O-Member
Spain	ES	P-Member
Sweden	SE	P-Member
Ukraine	UA	O-Member
United Kingdom	GB	P-Member
United States of America	US	P-Member

Index of Typical Test Standard

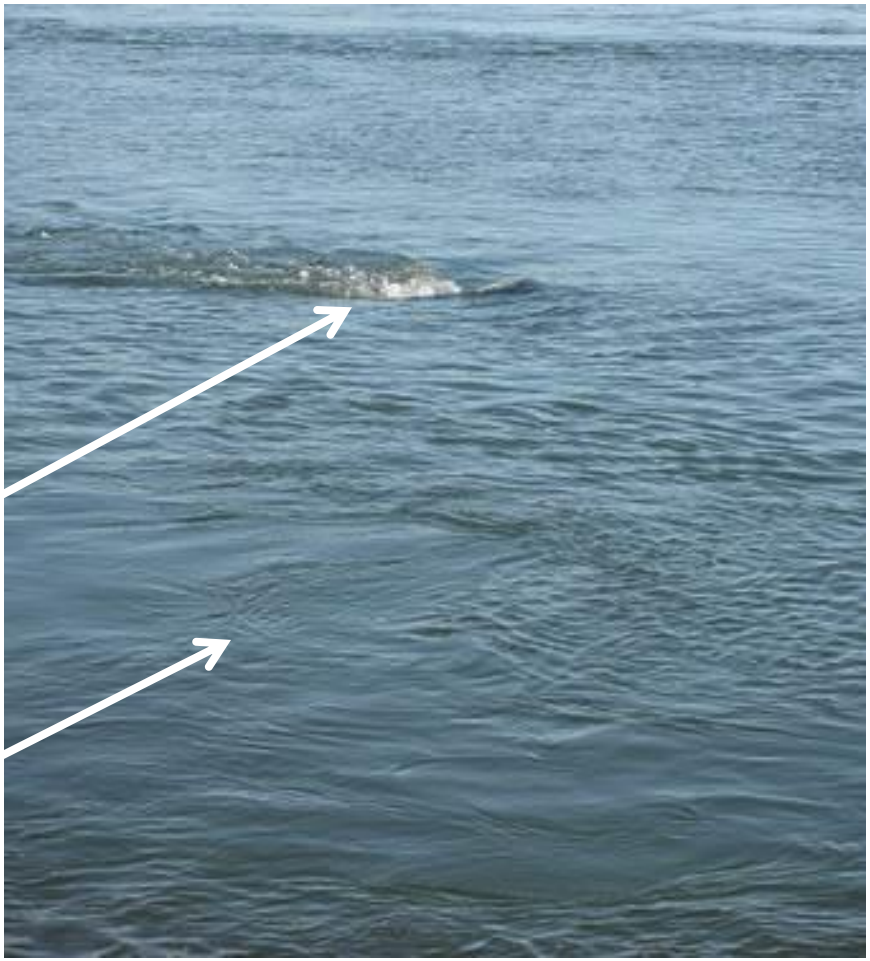
- 1. SCOPE
- 2. NORMATIVE REFERENCES
- 3. TERMS AND DEFINITIONS
- 4. SYMBOLS, UNITS AND ABBREVIATIONS
- 5. SITE AND TEST CONDITIONS
- 6. TIDAL ENERGY CONVERTER DESCRIPTION
- 7. TEST EQUIPMENT
- 8. MEASUREMENT PROCEDURES
- 9. DERIVED RESULTS
- 10. REPORTING FORMAT
- Annex A (Informative) Description of Availability
- Annex B (Normative) Categories of Error
- Annex C (Informative) Uncertainty Case Study

Site & Test Conditions

EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE

An example of things you don't need near your device under test:

- The wake from a submerged buoy
- This is an upwelling , arising from a "hump" in the seabed



Measurement Procedures

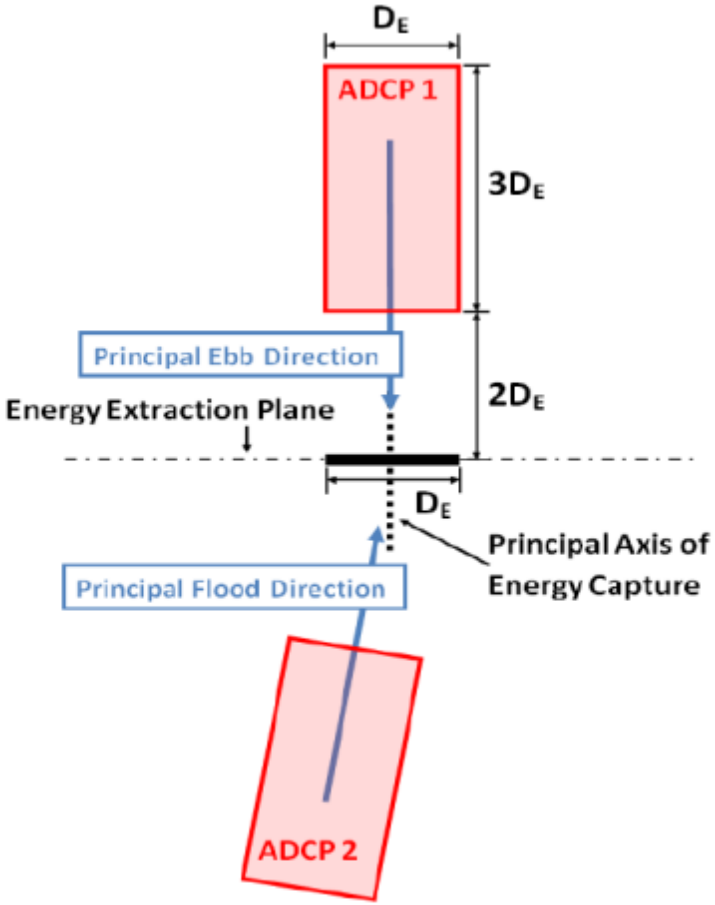


Figure 2: Orientation A for current profiler deployment (aerial view)

Deployment of ADCPs – fixed device:

- Red areas denote where ADCPs may be placed
- Note that no part of the beam must be closer than 2DE from extraction area.

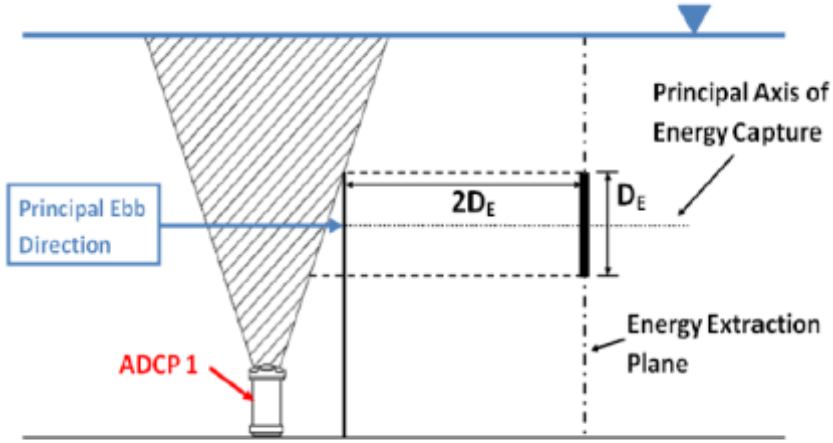


Figure 3: Orientation A for current profiler deployment (profile view)

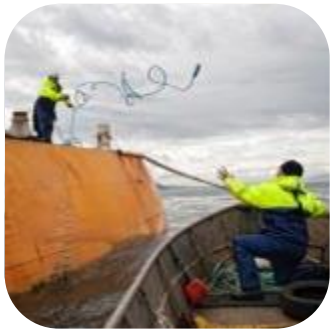
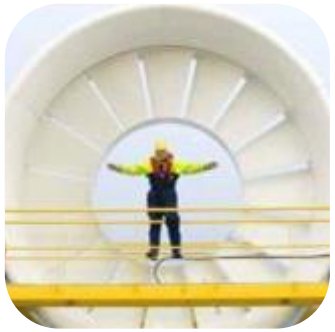
Conclusions

- Standards needed to show a maturing industry
- Standards do not stifle innovation
- Testing of MECs need to be the same method all over the world
- Defining the energy in the resources needs to be common
- International manufacture and assembly will rely on standards and shared methods

A GLOBAL CENTRE OF EXCELLENCE IN
MARINE ENERGY TESTING AND RESEARCH

EMEC 10
TEN YEARS OF MARINE ENERGY EXPERIENCE



For further information or involvement contact John Griffiths
john.griffiths@emec.org.uk

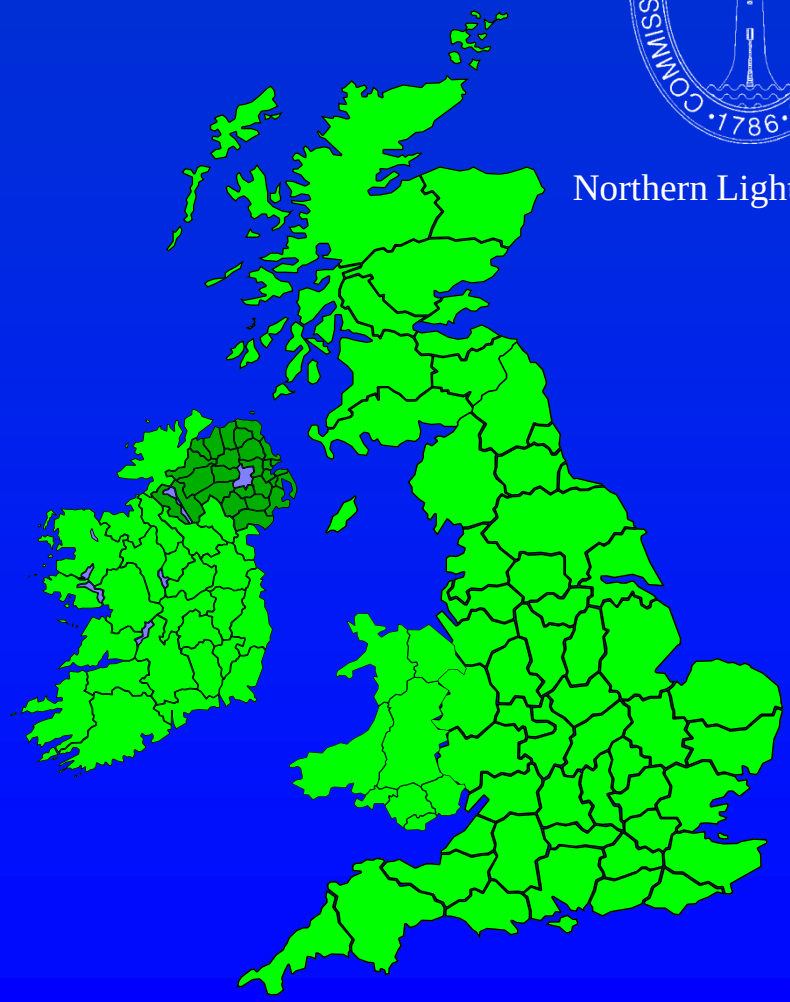
Northern Lighthouse Board

EMEC: Ten Years of Marine Energy Experience

17 October 2013

The General Lighthouse Authorities of UK (GLAs)

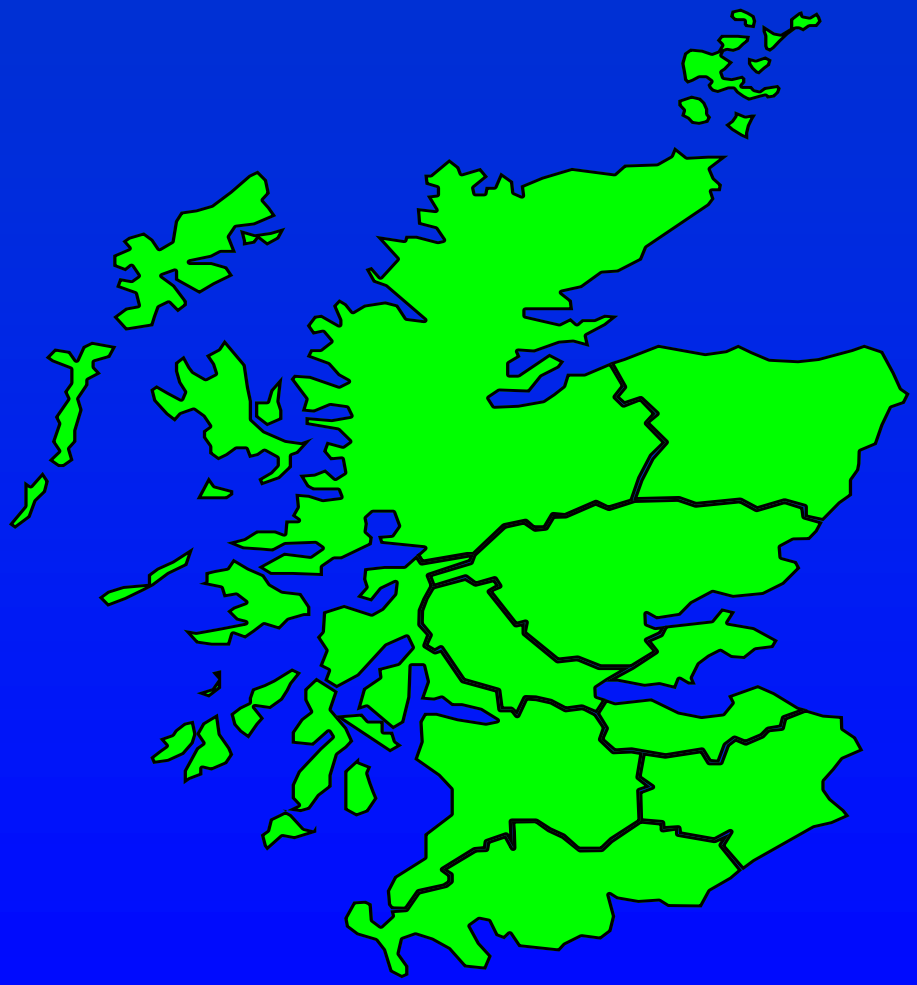
Northern Lighthouse Board



Commissioners of Irish Lights

Trinity House

THE NORTHERN LIGHTHOUSE BOARD



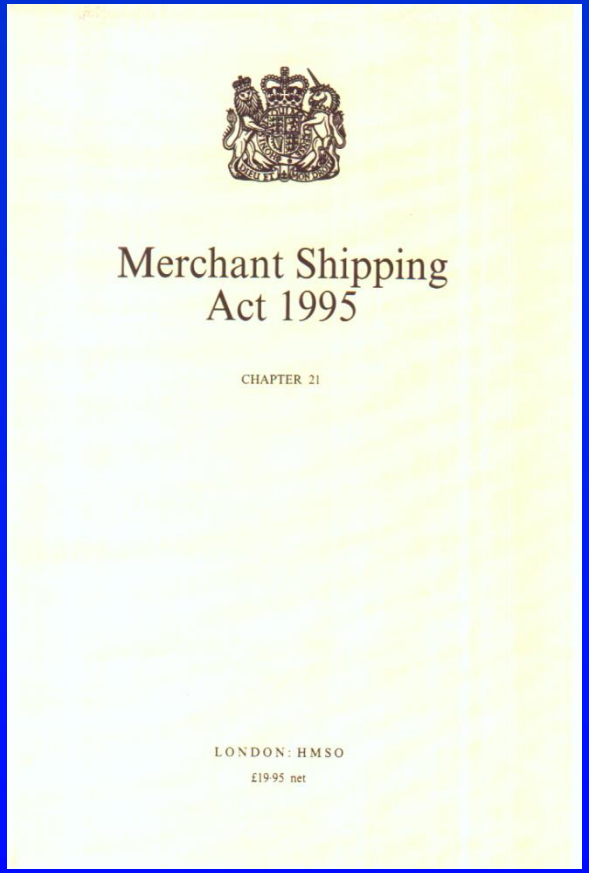
Legislation

First formed by statute in 1786 and now provided for in 1995 MSA:

"the general lighthouse authorities shall have the superintendence and management of all lighthouses, buoys and beacons within their areas"

fulfilling the UK's International obligation contained within the **S**afety **O**f **L**ife **A**t **S**ea Convention:

"each contracting Government undertakes to provide …..such aids to navigation as the volume of traffic justifies and the degree of risk requires"


Merchant Shipping Act 1995

CHAPTER 21

LONDON: HMSO

£19·95 net

International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA)

IALA

- International body founded 1959
- National, Associate & Industrial members
- Produces Recommendations & Guidelines - non-binding but best practice
- Guidance on marking of man-made structures in Recommendation O-139 (currently under revision)
- Also Maritime Buoyage System

IALA recommendation O-139

- On The Marking of Man-Made Offshore Structures, December 2008
- Allows for local interpretation (eg. UK Standard Marking Schedule)
- Includes:
  - Daymark properties
  - Lighting of individual or groups of structures
  - Use of sound signals, racons or AIS

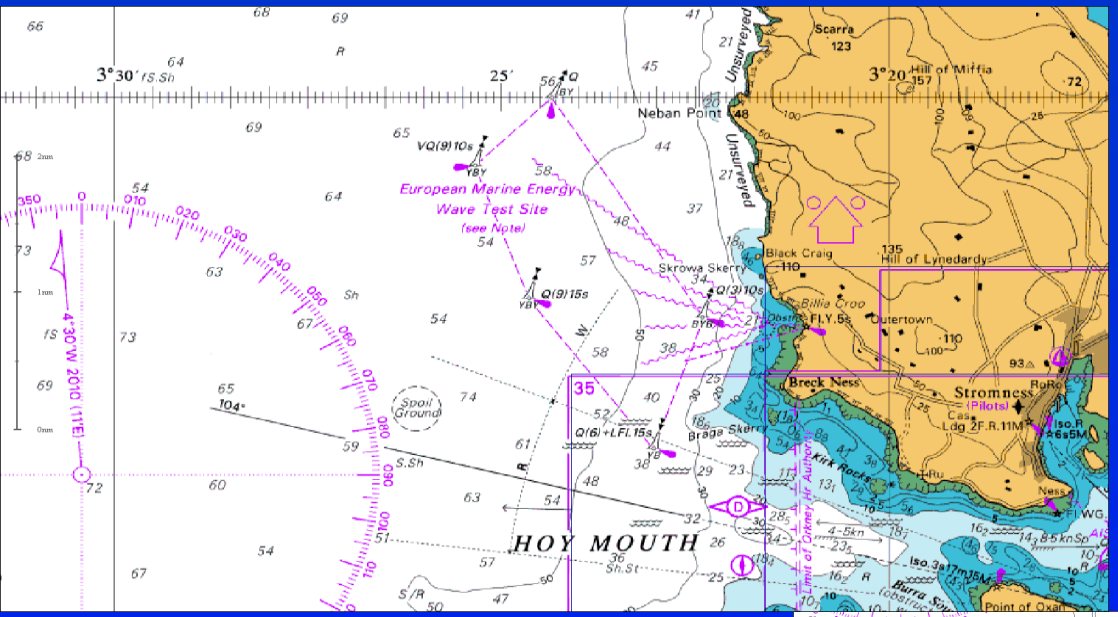
NLB & renewable energy

- Developers require consents under Marine Licensing & Electricity Acts
- Applications include a Navigational Risk Assessment, MCA – MGN371
- NLB is a statutory consultee and comments on all licence applications, stating marking requirements
- These become binding within Marine Licence

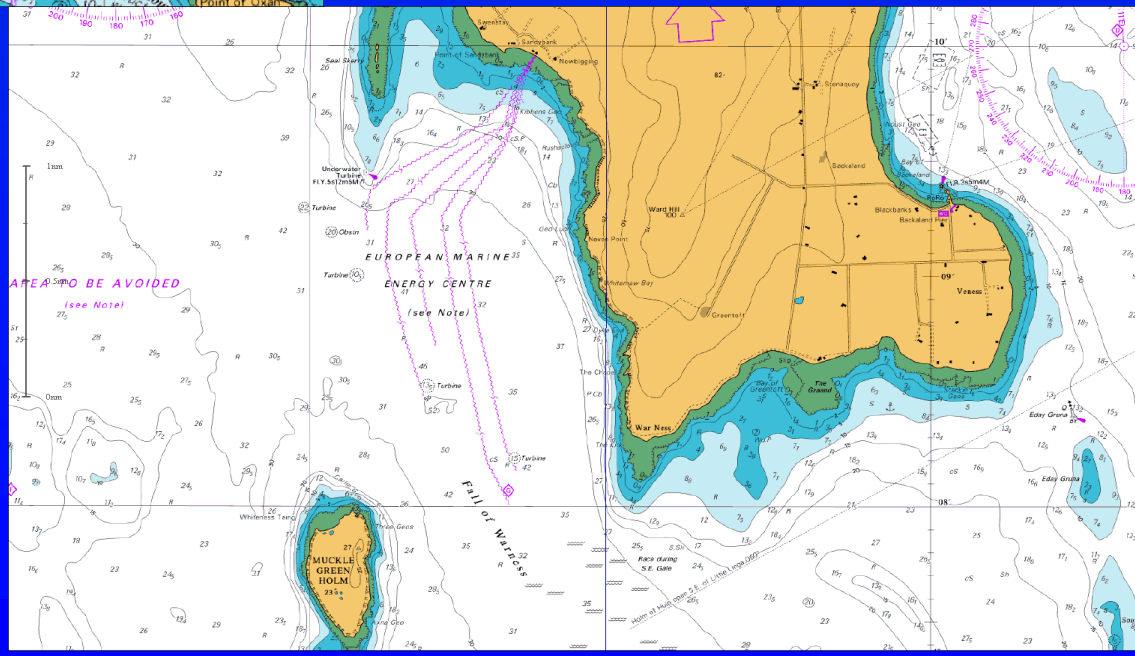
Wave & Tidal Energy

- Emerging industry
- Prototyping at EMEC, Strangford Lough, SW West Hub etc.
- Testing of increasingly larger devices in more severe conditions

Charting: EMEC test sites



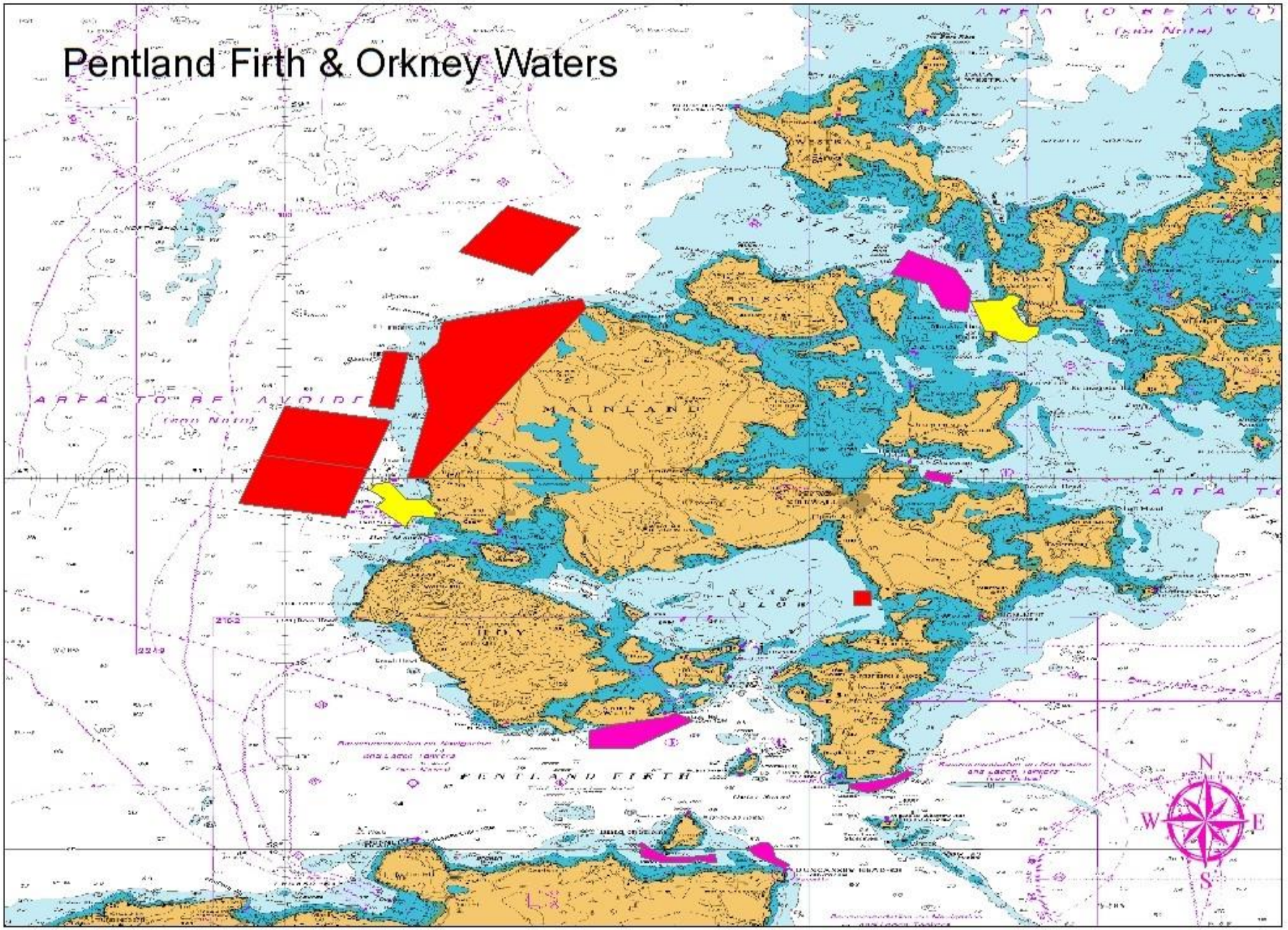
Billia Croo



Fall of Warness

Wave & Tidal Energy

- Well-established process towards site consents (scoping) & significant informal discussions between NLB and developers – based on 10 years experience of working with EMEC and at IALA
- Includes consideration of cumulative effects and practicality of marking sites – can safety be assured by use of vertical separation ?
- Early discussions avoid expensive misunderstandings !


Pentland Firth & Orkney Waters
MAINLAND
PENTLAND FIRTH
N
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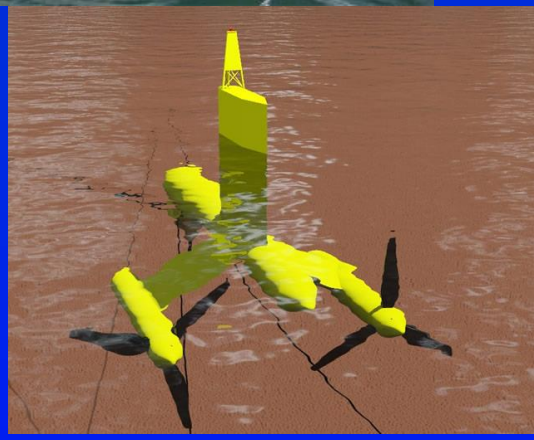
E
S

Marking & Lighting - surface

- Advice based on IALA O-139 in conjunction with experience gained at EMEC
- Surface-piercing / floating devices to be (predominantly) Yellow in colour, lit as Special marks, also radar reflectors
- Areas containing devices may marked with Cardinal Marks or other buoys as appropriate
- Contingency plans in case of device or mooring failure


ewo
pod
Ocean Flow Energy



Marking & Lighting - subsea

- Advice based on IALA O-139 in conjunction with experience gained at EMEC
- Difficulty in marking underwater tidal devices; primary protection by charting & minimum clearance depths
- Areas containing devices may marked with Cardinal Marks or other buoys as appropriate
- Contingency plans in case of device or mooring failure


Source: www.detini.gov.uk


Tidal Energy Device
Client: Open Hydro

Wave & Tidal Developments

- Crown Estate lease areas
  - Bernera - Pelamis Wave Power Ltd
  - Moray Firth - AWS Ocean Energy Ltd
  - West Islay - DP Marine Energy Ltd
  - Mull of Kintyre - Nautricity Ltd
  - Bluemull Sound - Nova Innovation Ltd
  - Sanda Sound - Oceanflow Development Ltd
  - Skerries - Marine Current Turbines Ltd
  - Strangford Lough - Minesto UK Ltd
- Also Aegir SW of Shetland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navigation@nlb.org.uk

Thank You

Navigation Safety and Renewable Energy Development in the Pentland Firth and Orkney Waters (PFOW) area

Jim McKie

Marine Scotland, Marine Laboratory, Aberdeen

The Scottish Government

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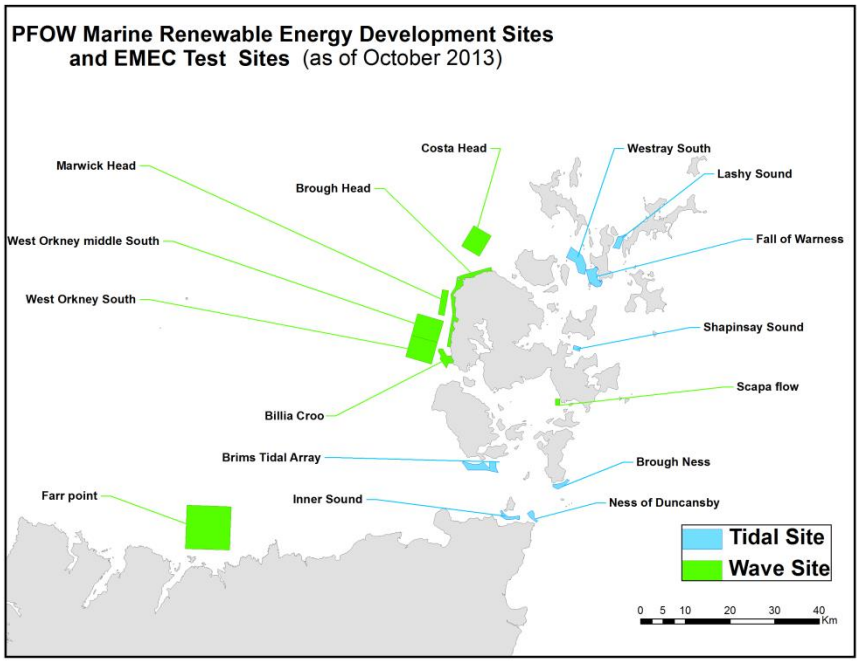
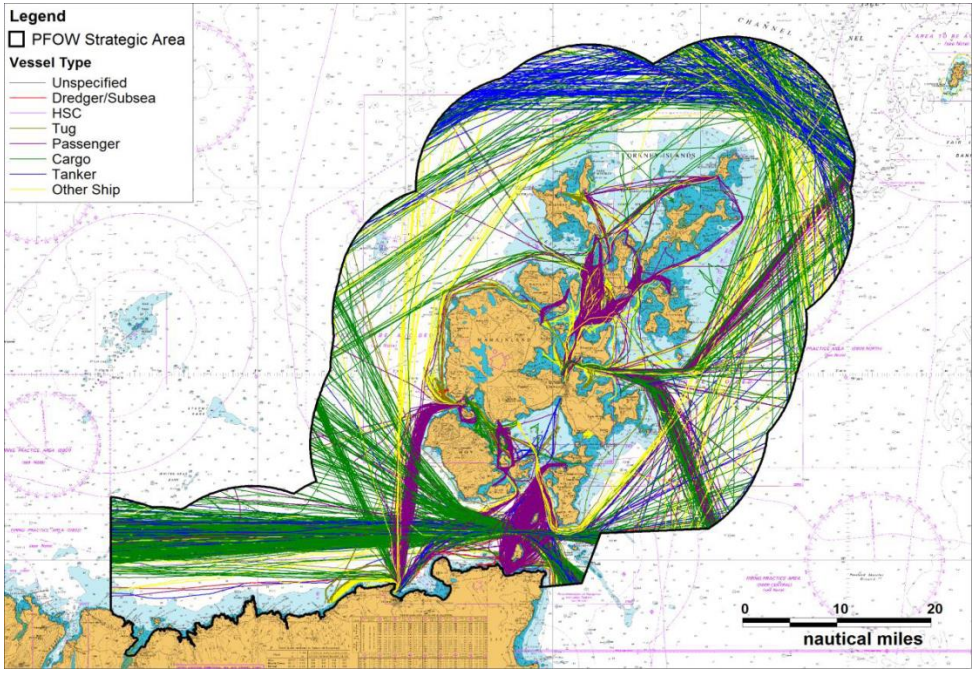
Introduction

- PFOW wave and tidal development and test sites
- Stakeholders
- Potential Navigation Impacts and Mitigation Options
- Success Stories – EMEC and Consented Projects
- Ongoing Work – Shipping Study, ScotMap, SANAP, MSP & RLG
- Conclusions





Stakeholders

- Northern Lighthouse Board
- Maritime and Coastguard Agency
- Commercial Fishing Associations
- Ferry Operators
- Recreational Users – RYA, SCA, sea angling groups, SaS
- Ministry of Defence
- Commercial Shipping Interests – CoS, SG Ports & Harbours
- TCE
- EMEC
- 12 PFOW Developers
- Harbour Authorities

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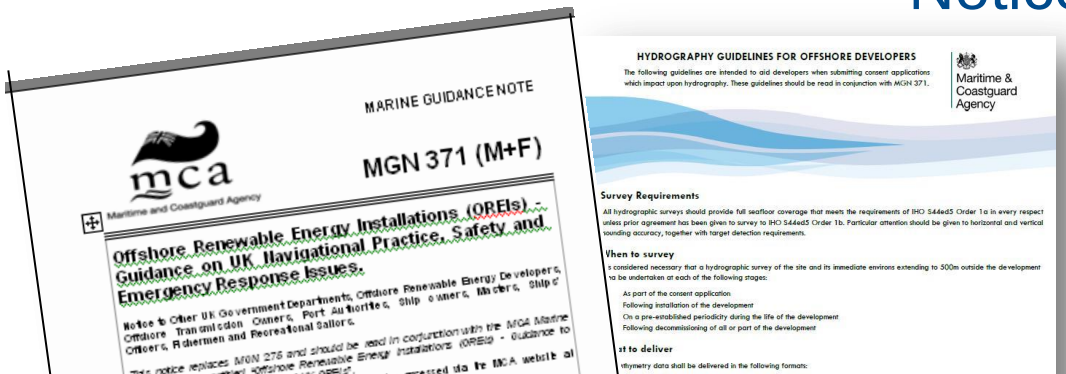
Potential Navigation Impacts and Mitigation Options

Potential Impacts

- Increased Traffic and Congestion
- Displacement
- Allision and Collision
- Access restriction (navigable route depths and widths)
- Cumulative and In-combination effects

Mitigation Options

- Site Layout
- Marking / Charting (e.g. EMEC)
- Routeing Measures (e.g. ATBA)
- Follow Guidance (IALA, MCA)
- Safety Zones (DECC)
- Notice to Mariners


MARINE GUIDANCE NOTE

MGN 371 (M+F)

Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response Issues.

HYDROGRAPHY GUIDELINES FOR OFFSHORE DEVELOPERS

Survey Requirements

When to survey

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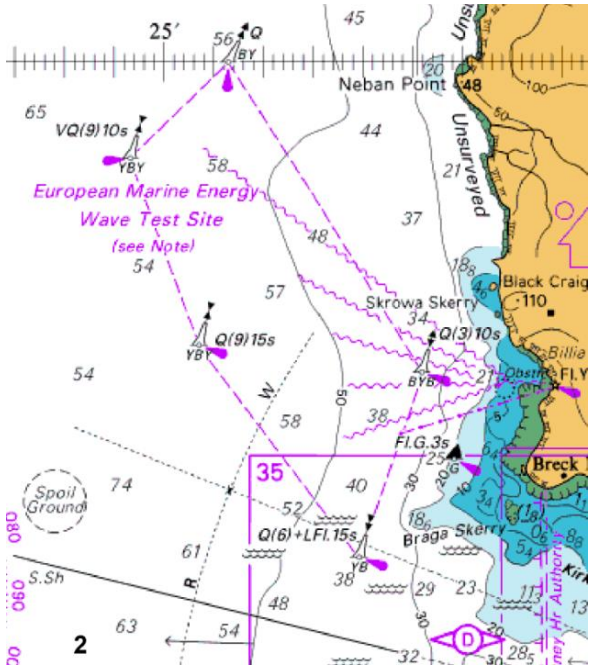
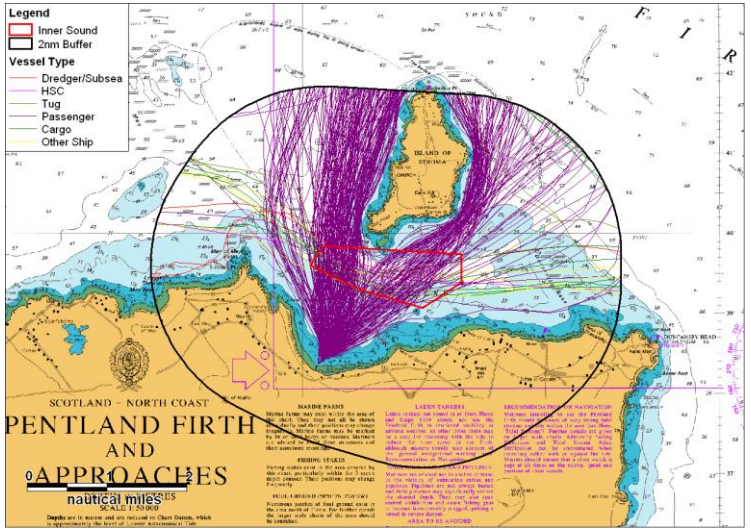
Success Stories – EMEC and Consented Projects

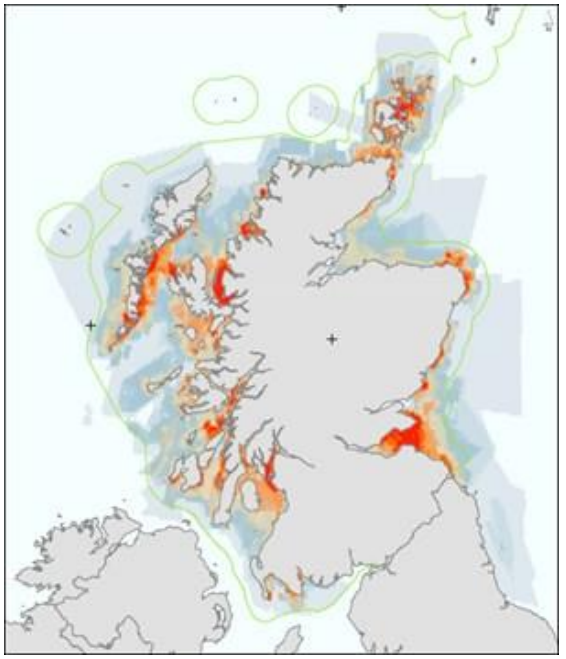
- EMEC
  - Billia Croo, wave test site
  - Fall of Warness, tidal test site
  - Small scale test sites, Scapa Flow (wave) and Shapinsay Sound (tidal)
- MeyGen Phase 1
  - 86MW tidal project, Inner Sound, Pentland Firth
- North West Lewis Wave Array
  - 40MW wave project, Outer Hebrides





Ongoing Work

- MS Shipping Study of the Pentland Firth and Orkney Waters
  - Commercial shipping and recreational vessels focus



- MS ScotMap project
  - fishing vessel activity, <15m fleet
  - Draft report focusing on PFOW available online
- Strategic Area Navigation Appraisal (SANAP) of PFOW
  - TCE commissioned (MS part of working group)
  - Cumulative and in-combination effects of projects
  - Identifies potential impacts and mitigation options
- PFOW Marine Spatial Plan and Regional Locational Guidance
  - Examines how development can progress in a way that avoids conflict with existing users of the sea

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Conclusions

- In order to successfully develop marine renewable energy projects in the confined area of the PFOW, it is essential for MS-LOT and PFOW Developers to engage with stakeholders to establish practical and appropriate solutions to the identified navigation hazards

- The cumulative and in-combination effects of the PFOW projects is a key concern and is being addressed partly by the SANAP

- The ongoing work mentioned should continue and will allow us to be prepared for current and future navigation safety challenges

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