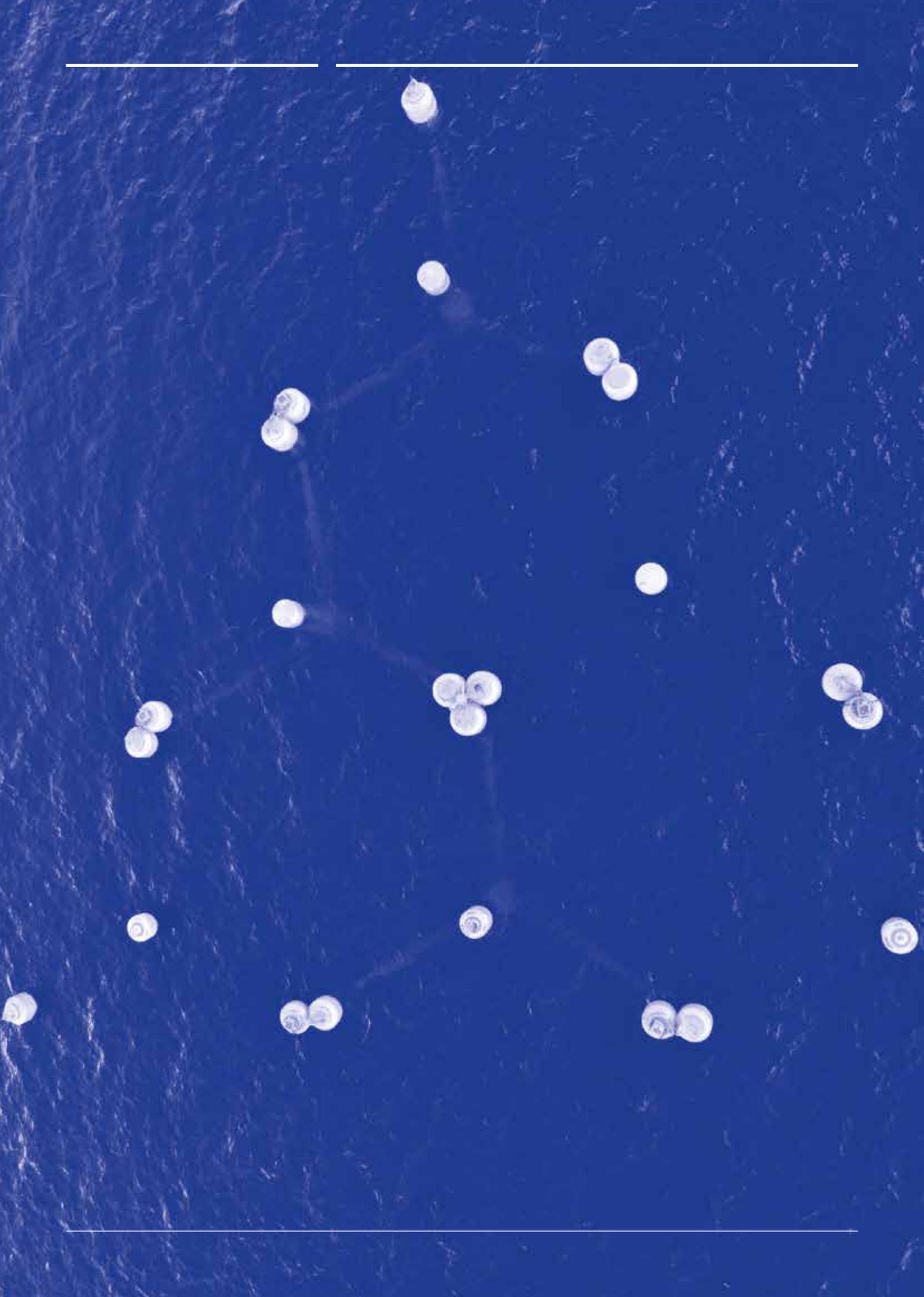




WAVE ENERGY SCOTLAND

PROGRESS REPORT
2016



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FOREWORD

Every good building relies on strong foundations, and the same can be said of any new industry.



TIM HURST
Managing Director
Wave Energy Scotland

In late 2014, Scotland's wave energy sector was in urgent need of better foundations and, in turn, some long-term stability. After more than a decade of rapid innovation, our country had become the undisputed world leader in wave energy, with flagship technology firms in the vanguard of this exciting new industry. However, securing funding in the sector had become a serious issue, with a growing realisation amongst investors that wave energy was unlikely to produce quick returns.

At the request of the Scottish Government, Highlands and Islands Enterprise was asked to establish Wave Energy Scotland (WES), with a mandate to bring continuity, structure and long-term confidence to the industry.

Now, almost two years on from our foundation, we have made outstanding progress. We have:

- Developed a large technology programme
- 129 companies, 39 projects and programme still growing
- Novel Wave Energy Converters completing Stage One
- Power Take Off projects progressing to Stage Two
- Plans to announce the Materials Call awards
- Controls call to be launched early 2017

This progress report provides highlights on our work and insights from our partners. Our collaborative programme is all about getting the basics right, supporting the development of systems and devices at different scales and methodically reducing the technical risk as they get closer to deployment.

We're under no illusions about the scale of the technological challenge, one that challenges our finest minds in the harshest of environments.

However, we're confident that our five-year programme will culminate with the deployment of innovative wave energy devices that have the economics, reliability, costs and performance needed to attract investment and pave the way for commercial production.

In the decades ahead, the world will continue to require new sources of green energy, and wave power has the potential to make a significant contribution to that growing demand.

As home to a cluster of world-renowned marine energy businesses, an established engineering skill base and world-class academic and research networks, Scotland is well placed to capitalise on this opportunity.

THE POWER TAKE OFF PROGRAMME



DAVID LANGSTON
Programme Manager

The WES technology development programme employs a Stage Gate approach to evaluating technologies and their progress onwards through the programme. Evaluation at each stage is shaped by the four metrics WES uses: availability, survivability, performance and affordability. The most promising projects then undergo competitive Stage Gate assessments, with those chosen to advance receiving further support from WES.

From the ten Stage One teams that entered the programme, four were selected to advance to Stage Two. There are currently six projects just reaching the end of Stage Two. Over the coming weeks these teams will have the opportunity to apply to reach Stage Three. This 24-month long stage represents a major step forward for the teams, with funding in the region of £2.5 million available per project.

Stage Three funding will enable successful contractors to thoroughly investigate and refine the performance of their Power Take Off (PTO) design, and understand in greater detail how it will operate and survive in a marine

environment. The primary focus of Stage Three will be on activity that will reduce the commercial risk for the technology.

Stage Gate applications will be reviewed by a team of expert assessors to determine which should progress to Stage Three. There are a number of broad technology types involved, including hydraulics, linear generators and ball screws. The contractors will have to demonstrate their achievements in Stage Two, and provide convincing arguments on why their solution represents the best way forward for the wave energy sector. They will also need to outline their targets against the WES criteria of affordability, performance, availability and survivability, as well as describe their proposed scope of work that will achieve these project objectives.

In the longer term, it is expected that a PTO development from this call will partner with a Wave Energy Converters (WEC) developer in the WES programme, ultimately building a device that can reliably deliver electricity at a competitive market price.

“WES has been invaluable at stimulating collaboration between companies that have part of what is required to deliver successful technologies.

Their robust scrutiny of proposals and the associated feedback is invaluable to the process and with this knowledge the collaborators scrutinise themselves.

Often it's the smallest company that has the purest and most valuable ideas but the partnership and support that WES offers can bring their technology to fruition.”

MIKE WILSON

Managing Director, Ecosse Subsea

“After what has been a very encouraging start by Tim Hurst and his team, WES’ technology development programme is now well underway and meeting its objective of supporting the ongoing development of a globally competitive wave energy industry within Scotland.

Tim and his team have succeeded in assisting the industry to maintain forward momentum, following a very challenging period. They have run a series of funding calls, specifically designed to support the development of a range of technology programmes essential to maintaining a competitive Scottish Wave Energy industry.

As a result of those efforts we can now look forward to both seeing the fruits of those commitments as they come to maturity as well as those planned for the future.”

STEVE THOMSON

Chair, WES Advisory Group



WAVE ENERGY SCOTLAND: AT A GLANCE

8 NOVEL WAVE
**ENERGY
CONVERTERS**
UNDERGOING TANK TESTING

129
COMPANIES
WE HAVE WORKED WITH

10
**EXPERIENCED
ENGINEERING
AND PROJECT STAFF**

12
**ACADEMIC
ESTABLISHMENTS**
INVOLVED FROM UK AND EUROPE

3 **FUNDING
CALLS
COMPLETED**

£11.8m
**INVESTED IN
39 PROJECTS
OVER 2 YEARS**

11 **COUNTRIES**
WITH COMPANIES INVOLVED

**OVER
200** **YEARS OF
WAVE ENERGY
TECHNOLOGY EXPERIENCE**
IN THE TEAM AND ITS ADVISORY GROUP

INTERNATIONAL COLLABORATION



ELVA BANNON

Senior Research Engineer
Wave Energy Scotland

The challenge to develop a commercially viable wave energy technology is not something a single country can easily tackle on its own, without a focused technology programme. There have been several different wave energy projects across the globe over the last 50 years, but for a plethora of reasons, these have failed to thrive.

The revived interest in wave energy technology, together with the innovative approach being taken by WES, has captured the attention of public agencies worldwide who are all tackling the same challenge.

An international effort is required to develop commercially viable wave energy technology and so collaboration on a global scale is now essential.

Sharing a common set of development goals and metrics will ensure that developers, investors and funding agencies, in any country, are able to compare technologies in a consistent way.

WES, the International Energy Agency, US Department of Energy (DoE) and agencies from across Europe are now cultivating this international collaboration.

Three international workshops were held in 2016 to help bring together the main stakeholders and to agree a set of metrics for evaluating WEC technologies.

This approach, being led from both sides of the Atlantic, will help bring about the creation of a more structured methodology for technology progression and evaluation.

Ultimately, for any public funding agency, the aim is to support technology development to a point where private investors have increased confidence in the future prospects for wave energy and are willing to invest in the sector.

“Both organisations need to set targets for technology advancement and evaluate success for wave energy projects against established criteria.

Collaborating on developing these metrics is not only helpful for funding agencies, but also the industry developers being asked to report to these metrics.”

ALISON LABONTE

US Department of Energy

CONVERTING WAVE ENERGY THE WECS

“EMEC and WES work closely together to ensure that the technologies going through the WES Stage Gates benefit from the knowledge and experience learned previously throughout the industry. We want to ensure a smooth pathway for technology developers from concept, through WES, and ultimately to EMEC where they will test in real sea conditions prior to commercialisation.”

NEIL KERMODE

Managing Director
European Marine Energy Centre

Wave Energy Scotland’s second call was for the development of novel Wave Energy Converters (WECs) - the part of a wave energy device that turns the movement of the sea into mechanical energy.

At Stage One of the WES assessment, projects were expected to develop their proposed concept, assessing its performance characteristics and ability to capture energy.

As an essential first step in the process, project teams designed and built scale models of concept converters, which were then put through their paces in controllable wave tank environments.

Observing a model’s response in a wave tank provides invaluable insight into the likely behaviour of a full-scale prototype in the open sea. Equally, the measurement of a model’s motions, and the forces it experiences, quantifies the design’s ability to capture wave energy. Information obtained from wave tank testing also supports the development of complementary numerical modelling activities, providing a ground truth upon which to calibrate simulations of the converter’s behaviour.

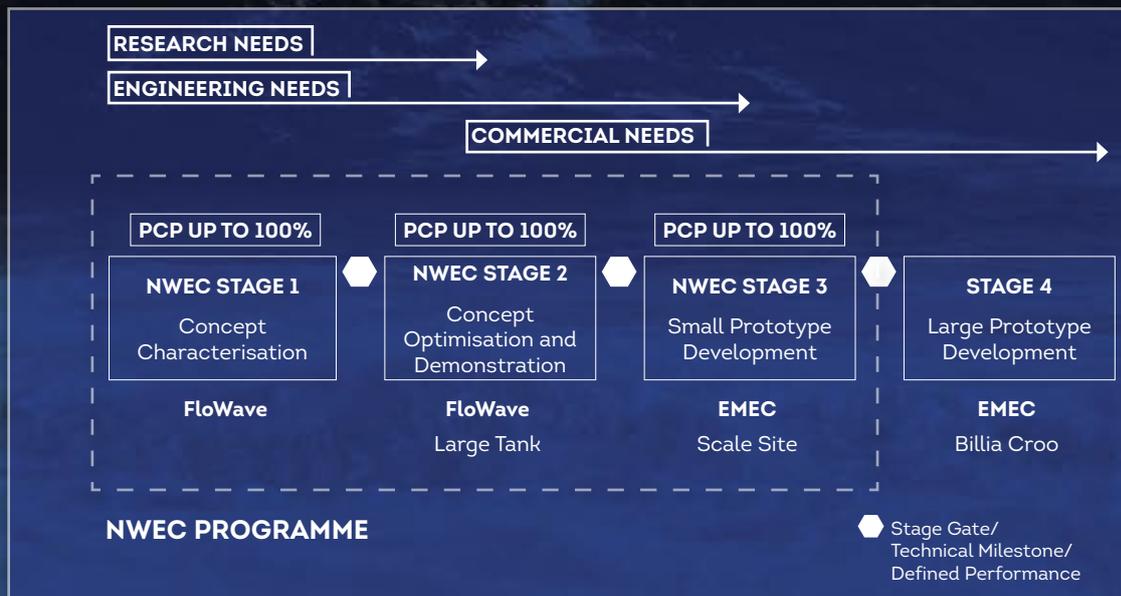
Constructing scale models and buying access to wave tanks can be expensive, but it is a highly effective and proven

method of exploring preliminary design options, helping shape the subsequent development of converter concepts.

At Stage Two of the WES assessment process, projects will be expected to focus on assessing the reliability, survivability and manufacturability of the full-scale concept. This will be done through detailed engineering analysis and by identifying and resolving technology challenges with credible, robust mitigations, justified by evidence, calculation and testing. The analysis will be informed by further small-scale wave tank testing to characterise extreme and fatigue loading, and quantify the benefit of increasingly sophisticated control strategies for improved survivability and enhanced energy capture.

The expectation is that the refinement of the full-scale concept will confirm its potential to deliver a cost effective wave energy technology. Stage Two will conclude by developing a design for a sea-going scale-model prototype that will be constructed and deployed in Stage Three.

Progression through the WES programme is via a competitive Stage Gate process, which the novel WEC Stage One projects will begin in early in 2017.



PROJECT CALLS: PROCESS AND HIGHLIGHTS



JONATHAN HODGES
Senior Innovation Engineer
Wave Energy Scotland

To assist us in scoping our calls, WES commissions external experts to carry out landscaping studies. These studies gather baseline knowledge and investigate the current state-of-the-art for the technology area forming the topic of the WES call(s). The studies also identify, and build an understanding of, the key challenges facing the particular area to help guide the direction of the call.

Landscaping studies were recently carried out to determine the typical forces experienced by a Wave Energy Converter (WEC) at sea, and also to investigate the different types of materials and manufacturing processes which could be used in WEC construction. The results from these studies formed the backbone of the third and most recent WES call - Structural Materials and Manufacturing Processes (SMMP) – released in July 2016.

WEC structures account for a significant proportion of the capital cost of a device, so the possibility of moving away from traditional construction (using steel or concrete) presents real opportunity for Levelised Cost of Energy reduction – a key WES objective. Guided by our landscaping studies, we asked the wider engineering sector to assess the attractiveness of rotationally moulded polymers, elastomers and concretes - or to demonstrate that other materials and manufacturing processes would deliver step-change improvements.

There was a healthy response to this, our third call, with applications from a strong cross-section of industry and academia. Selected projects will be announced early in the New Year after an assessment process by the WES team with the input of independent, external experts.

The new SMMP projects will follow our familiar three-stage WES format, from Stage One feasibility studies, through to risk reduction testing and manufacturing demonstrations in Stages Two and Three.

Successful projects will take promising materials or processes right through to readiness for integration with other technology development projects, including those in the WES Novel Wave Energy Converter programme. During this activity, we will continue to seek technology transfer from other industries to support progress towards commercially viable wave energy technologies.

Our landscaping study carried out by Quoceant and ORE Catapult earlier this year, will shape our next innovation call - Control Systems. Planned for spring 2017, this will follow the pattern of our other funding calls.

“WES is setting the right market conditions for Wave Energy Converter development through concept analysis, Stage Gate funding and sharing of knowledge

This perfectly complements our own approach and we continually look at ways where we can work more closely together to accelerate commercial readiness.”

SIMON CHEESEMAN
Wave and Tidal Specialist
ORE Catapult

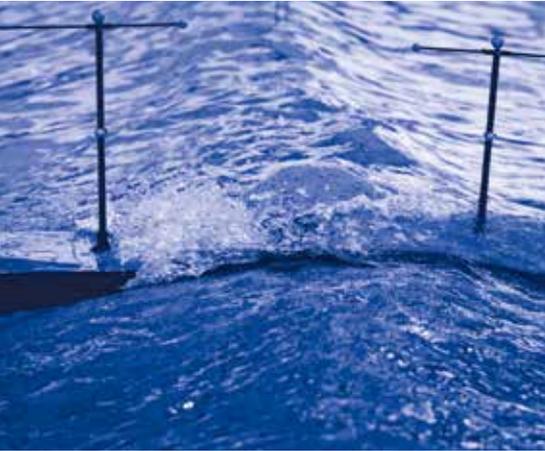
MANAGING OUR INNOVATION CALLS

Shortly after any call announcement, when documentation becomes publicly available online at Public Contracts Scotland (PCS), we run a short, live webinar.

During the webinar, participants can ask questions about procedures and the scope of the call. Around a month later we hold a free brokerage event, which is primarily designed to facilitate networking and to develop new collaborations.

We use an online business profiling website to help businesses book a schedule of meetings in advance.

Throughout the call, which is usually open for 8-9 weeks, interested parties can ask questions via PCS before submitting their completed applications.



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