Advanced Design Tools for Ocean Energy Systems Innovation, Development and Deployment

Deliverable D2.1

Results from user-groups consultation

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EXECUTIVE SUMMARY

The DTOceanPlus project will develop and demonstrate an open-source integrated suite of 2nd generation design tools for ocean energy technologies. The tools will support the entire technology innovation and advancement process from concept, through development, to deployment, and will be applicable at a range of levels: sub-system, device, and array.

This report presents findings from a consultation of potential users and other stakeholders for the DTOceanPlus tools, to identify and clarify their needs and requirements. Opinions from over 70 industry professionals from a wide range of backgrounds were collated and analysed. These will be used to inform the functional requirements for the development of the DTOceanPlus tools and software.

Further work is required during the DTOceanPlus project to explain the functionality and use of the proposed tools, particularly focusing on the Structured Innovation concept as this is less well understood. Additional clarification of the tool's scope would also be beneficial, in terms of stages of the development lifecycle covered, how this links with TRL, and to different points during a project.

Of the overall software characteristics considered, usability followed by flexibility & expandability then modularity were seen as most important. Additionally, transparency of how the tools work is critical, including documentation referenced to background research, and some form of version control or parameter tracking. A high-quality software product is expected of DTOceanPlus, something not all people consider DTOcean delivered.

The proposed tools will need to deal with varying degrees of complexity, both at different stages in the project lifecycle and also for different user requirements. How this will be dealt with was a concern for some. A suggestion was to have 'high-level' and 'technical' tools (or 'simple' and 'expert' modes), exposing more detail in the latter for those who have data and time available to do more analysis.

Several responses stressed the importance of linkages between the tools, and with external software. One technology developer suggested having an API to allow external software and scripts two-way access to the DTOceanPlus tools and data, allowing flexibility to use either DTOceanPlus or another tool as deemed most appropriate.

Nearly all respondents (>85%) indicated that they were likely or very likely to use DTOceanPlus at some stage in the project lifecycle. Similarly, most (>80%) responded that they understood or somewhat understood conceptually what all the DTOceanPlus tools would do.

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ABBREVIATIONS AND ACRONYMS

AEP	Annual Energy Production
API	Application Programming Interface
BV	Bureau Veritas
CAD	Computer Aided Drawing/Design
CSV	Comma Separated Variables
EnFAIT	Enabling Future Arrays in Tidal
ESC	Energy Systems Catapult
FMEA	Failure Modes and Effects Analysis
GIS	Geographical Information Systems
GUI	Graphical User Interface
IP	Intellectual Property
LCOE	Levelised Cost of Energy
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
PTO	Power Take-Off
QFD	Quality Function Deployment
R&D	Research and Development
TRIZ	*Teoriya Resheniya Izobretatelskikh Zadatch*, (theory of inventive problem solving)
TRL	Technology Readiness Level
UEDIN	University of Edinburgh
WES	Wave Energy Scotland
WP	Work Package

1. INTRODUCTION

1.1 SCOPE OF REPORT

This report is the outcome of DTOceanPlus Task 2.1 'User-group consultation'. The aim of this task is to consult appropriate stakeholder groups to gather their requirements for advanced ocean energy design tools. The results shown in this report will be used as a baseline when developing the requirements for DTOceanPlus through Task 2.2, and the relevant tasks in WP3, 4, 5, 6 and 7 of the DTOceanPlus project.

A range of stakeholder types were identified, which comprise both prospective ocean energy design tool users and other interested parties, in the following categories:

i) Public funders, commercial investors, and insurance providers;
ii) Innovators and developers;
iii) Project developers, utilities, and supply chain; and
iv) Policy makers, regulators, and standardisation bodies.

To understand the needs of the DTOceanPlus users and other stakeholders, and to focus the development of the DTOceanPlus tools, a user needs consultation exercise was undertaken. This was split into three stages:

- An online webinar held on 6 July 2018 introduced this consultation, and the DTOceanPlus project.
- A web-based questionnaire gathered feedback from as many potential users as possible. This included questions on understanding and likely use, plus the importance of various elements of the software and tools. Clarifications were sought from a number of questionnaire respondents, to assist with the understanding of some answers.
- Focused interviews were also held with key stakeholders, to better understand their needs, and give more nuanced feedback than was possible in the consultation.

In addition, feedback on the original DTOcean software was reviewed for suggested improvements.

Following on from this work, the functional requirements for the DTOceanPlus software and tools will be developed in Task 2.2, which will be summarised in Deliverable D2.2.

1.2 OUTLINE OF REPORT

The rest of this report is structured as follows. Background on the proposed DTOceanPlus software is given in section 1.3, with feedback on the original DTOcean software in section 1.4.

Section 2 outlines the methodology adopted for the user needs questionnaire and key stakeholder interviews. The results of the consultation are summarised in section 3, presenting quantitative results graphically together with comments received in the questionnaire and interviews.

Conclusions and next steps are then given in section 4.

1.3 BACKGROUND ON DTOCEAN AND DTOCEANPLUS

DTOCEAN

The DTOcean Project[1] produced a first generation of freely-available open-source design tools for wave and tidal energy arrays. This project ran between 2013 and 2016, and was funded under the EU FP7 framework Grant Agreement № 60859 [1]. The project built an integrated suite of tools [2] split into five modules or stages:

- **Hydrodynamics**: designs the layout of converters in a chosen region and calculates their power output.
- **Electrical sub-systems**: designs an electrical layout for the given converter locations and calculates the electrical energy exported to shore.
- **Moorings and foundations**: designs the foundations and moorings required to secure the converters at their given locations.
- **Installation**: designs the installation plan for the energy converters and the components required to satisfy the electrical sub-system and moorings and foundations designs.
- **Operations and maintenance**: calculates the required maintenance actions and power losses resulting from the operation of the converters over the lifetime of the array.

These were brought together by a global decision tool containing optimisation routines that can evaluate each stage of the design, and the design as a whole, using three thematic assessments:

- **Economics**: produces economic indicators for the design, in particular the Levelised Cost of Energy (LCOE).
- **Reliability**: assesses the reliability of the components in the design over the array lifetime.
- **Environmental**: assesses the environmental impact of each stage of the design.

DTOCEANPLUS

Building on this solid foundation, the H2020 funded DTOceanPlus project[2] will develop and demonstrate an open-source integrated suite of 2nd generation design tools for ocean energy technologies [3]. These tools will support the entire technology innovation and advancement process at various stages of maturity from concept, through development, to deployment. They will be applicable across a range of technology levels, namely: sub-system, device, and array.

The DTOceanPlus software will comprise a number of 2nd generation tools, which are summarised below and illustrated at a high level in figure 1.1. The deployment and assessment tools were presented together for the consultation, as there is commonality between these and they both build on the original DTOcean tools.

[1] http://www.dtocean.eu/
[2] http://www.dtoceanplus.eu/

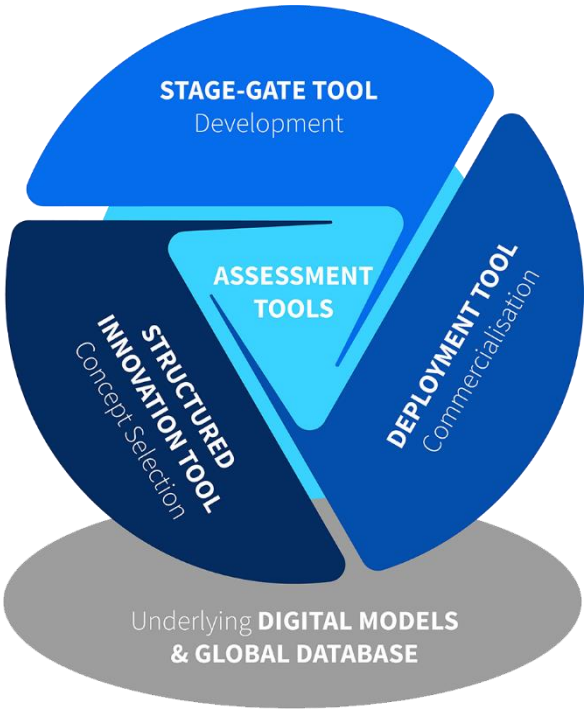


FIGURE 1.1: REPRESENTATION OF DTOCEANPLUS TOOLS

- **Structured Innovation Tools,** for concept selection and design. This will consist of three tools:
  - Quality Function Deployment (QFD),
  - TRIZ (Theory of Inventive Problem Solving), and
  - Failure Modes and Effects Analysis (FMEA).
- **Stage Gate Tools,** using metrics to measure and assess technology development. This will develop:
  - A stage-gate structure.
  - Metrics and success thresholds.
  - Tools for measuring success and analysis performance against metrics and thresholds.
  - Stage gates and metrics graded to the relevant stage in the technology development process.
- **Deployment Tools,** supporting optimal device and array deployment. These will improve and expand on the capabilities of the original DTOcean software to consider:
  - Site characterisation (e.g. metocean, geotechnical, and environmental conditions)
  - Energy capture at an array level
  - Energy transformation (PTO and control)
  - Energy delivery (electrical and grid issues)
  - Station keeping (moorings and foundations)
  - Logistics and Marine Operations
- **Assessment Tools**, used by the other tools to quantify the following:
  - System Performance and Energy Yield
  - System Lifetime Costs
  - System reliability, availability, maintainability, survivability (RAMS)
  - Environmental and Social Acceptance

- Underlying these will be **common digital models and a global database**.
  - These will provide a standard framework for the description of sub-systems, devices and arrays.
  - As well as being a communication method for the various tools, this will provide a common language for the entire sector.

The DTOceanPlus tools will be designed to be used throughout the project lifecycle, at various stages of technology development, with increasing level of data available and detail required at each. For the consultation, this was illustrated as split into three stages, broadly linked to the widely used technology readiness levels (TRL):

- **Concept definition** (TRL 1-3): early stage analysis of potential device or site. Gives an overview of capabilities and next development steps, but may be based on limited data.
- **Feasibility** (TRL4-6): includes an in-depth study of the topics covered in the concept definition. More accurate than previous stage, with additional data requirements.
- **Design** (TRL 7-9): key project features are planned in this stage, informed by the previous phases. Makes use of detailed information about the project.

It is important to note however, that concepts, feasibility and design are required at all stages of the technology development process. They may also be assessed at a different number of stages.

As well as being used at different stages in the project development lifecycle, DTOceanPlus will also be applicable to three different levels of technology, specifically:

- **Sub-system**, e.g. PTO, or moorings and foundations, which go towards making the device.
- **Device**, i.e. one complete system that can be deployed individually or to make up an array.
- **Array** of multiple devices.

1.4 FEEDBACK ON ORIGINAL DTOCEAN SOFTWARE

A number of other sources of information relating to the original DTOcean software were reviewed to gauge user issues and suggested improvements. These limitations and issues should be addressed as part of the DTOceanPlus development.

USER REPORTED ISSUES AND ERRORS

Various issues and errors were reported by users via the project mailing list [4] and the GitHub issues page [5]. Many of these appear to relate to the installation process, for both the application and the database. A common theme from this is missing libraries or other dependencies. This was also highlighted in one detailed response to the questionnaire.

As mitigation, use of the Salome Platform, and having a software developer (Open Cascade) as part of the DTOceanPlus consortium, should help to alleviate these software issues. As a separate initiative, Tecnalia and the University of Edinburgh are developing an improved installation guide for the original DTOcean software which will be published on the DTOcean GitHub repository [5].

ENFAIT PROJECT WP10 – VALIDATION OF ARRAY MODELLING TOOLS

The H2020 project Enabling Future Arrays in Tidal (EnFAIT)[3], Grant Agreement № 745862, will carry out a demonstration of a grid-connected tidal energy array with the aim to provide a step change in the lifetime cost of energy for tidal power. The project plans to adjust the layout of the turbines in order to enable array interactions and optimisation to be studied for the first time at a real tidal energy site [6].

One work package (WP10) of the EnFAIT project is to validate array modelling tools, specifically the original DTOcean tool against the constructed array. A number of limitations of the software were highlighted as part of a project document [7], which are summarised below.

- The turbine location is only based on maximising annual energy production (AEP), however other boundaries should also be considered, as turbine placement influences capital, installation, and O&M costs.
- Only the general direction of the array can be altered, where all devices are similarly aligned with each other.
- An offshore substation is always included in the array with a single export cable to shore, however small arrays may use individual cables per turbine.
- The foundation type for the offshore substation can only be piled.
- The options available for cable installation method are jetting, ploughing, cutting, and dredging. Laying the cable on the seabed is not included.

These limitations should be all be addressed as part of the DTOceanPlus Deployment and Assessment Tools development

[3] www.enfait.eu

2. METHODOLOGY

2.1 INTRODUCTORY WEBINAR AND BACKGROUND INFORMATION

An online webinar was held on 6 July 2018 to introduce the project and consultation. This was led by The University of Edinburgh (UEDIN), with support from Energy Systems Catapult (ESC), Wave Energy Scotland (WES), and Tecnalia. This gave a brief introduction to the DTOcean and DTOceanPlus projects, and the proposed consultation. A summary was then provided of the main tools within DTOceanPlus: ESC introduced the Structured Innovation Tools; WES the Stage-Gate Tools; and Tecnalia summarised the Deployment and Assessment Tools. Finally, the online questionnaire was introduced by UEDIN.

The webinar was recorded and linked from the introductory page of the consultation, for those who were not able to attend live. The slides from this are included in ANNEX II: Introductory webinar slides, and the recorded webinar is now available on the DTOceanPlus website [8].

In addition to the webinar, a two-page background factsheet was prepared, covering both the original DTOcean project and the aims for DTOceanPlus. This is included as ANNEX III: Factsheet on DTOcean and DTOceanPlus.

2.2 PARTICIPATION

Participation in the user needs survey was entirely optional. To gain the widest possible audience, links to the introductory webinar and online consultation were widely shared by DTOceanPlus project partners on social media and by email to contacts. A reminder was sent to all users that registered for the webinar, but had not completed the questionnaire after two weeks.

The survey was open for responses for just over six weeks, between 6 July and 20 August 2018, with the deadline extended as late as possible to achieve the largest possible response during the holiday period.

Respondents were asked whether they wished to engage with the DTOceanPlus project in future, if so they were required to provide contact details. They were also able to indicate whether they wished to receive a summary of the findings, and if they would be willing to participate in a follow up interview.

It was possible to respond to the questionnaire anonymously, however there was space to provide optional details about their organisation: type, name, their role, and country they are based in. All responses to the questionnaire have been aggregated, and are not individually attributable, which was highlighted to participants. The views given in the consultation do not necessarily represent those of their employing organisation.

Staff from all partners in the DTOceanPlus consortium participated in the consultation, although the majority of responses were from people not involved in the project.

2.3 QUESTIONNAIRE DETAILS

A web-based questionnaire was developed to help understand the needs of the DTOceanPlus users and other stakeholders. This was developed to gather feedback from as many potential user as possible. It included questions on understanding and likely use, plus the importance of various elements of the software and tools.

The questionnaire used the JISC Online Surveys platform [9]. It had a total of 36 questions spread over six pages, covering: user details; general aspects of DTOceanPlus; the Structured Innovation Tools; the Stage Gate Tools; the Deployment & Assessment Tools; and Other Comments. These questions were a mix of multiple choice options, importance rankings, and free text input boxes to add in additional details. Users were requested to provide as much information as possible within these, including to explain their choices if required.

All questions were optional, therefore the total number of responses received varies by question, and the percentage of respondents does not always total 100%. For some questions it was also possible to select more than one answer, which are specifically noted in the results. A full list of questions is given in ANNEX I: Consultation questions, with results detailed in section 3.

Only those users that consented electronically to the terms of the survey were able to complete it. These are summarised in figure 2.1, with further details in an attached informed consent summary document, reproduced as ANNEX IV: DTOceanPlus Informed Consent Form.

You can respond anonymously, but any details you provide will better help us to further understand our users. Your responses will be sent to Online Surveys (www.onlinesurveys.ac.uk), where data will be stored in a password protected electronic format. Online Surveys does not collect identifying personal information as part of the survey, therefore your responses will remain anonymous unless you decide to provide your details. Published responses to the questionnaire will be aggregated and not individually attributable.
If you wish to engage with the DTOceanPlus further throughout the project, you may provide personal contact details in Question 2. These may be shared within the DTOceanPlus consortium strictly for the purposes of this project.
If you are interested in participating in an additional interview (by phone, in person, or email) please indicate so in Q2.c. We will send you a summary of the results if you wish, see Q2.d.
Further details of how the questionnaire responses will be managed are given in this attached informed consent summary.
You may print a copy of this consent for your records. Clicking on the "Agree" button below indicates that:
You have read the above information.
You voluntarily agree to participate.
You are 18 years of age or older.

I agree to the terms above ☑

FIGURE 2.1: CONSULTATION TERMS SUMMARY

2.4 ANALYSIS OF QUESTIONNAIRE RESULTS

The questionnaire results were imported into the mathematical software MATLAB R2018a for analysis, with only minimal cleaning of missing or bad data required. One response was excluded from the analysis as it did not answer any of the questions.

As part of the analysis, respondents were grouped into one or more of the following four categories based on the optional user classification information provided:

i) Public funders, commercial investors, and insurance providers;
ii) Innovators and developers;
iii) Project developers, utilities, and supply chain; and
iv) Policy makers, regulators, and standardisation bodies.

The results of some questions are shown disaggregated by these user categories. A small number of respondents (<5%) did not provide information about their organisation, so these had to be excluded from this part of the analysis. Some users fit into more than one category based on the information they provided, and their responses are included within each relevant category.

For certain other questions the response data has additionally been disaggregated by knowledge/use of the DTOcean software, or by those involved in the DTOcean and DTOceanPlus projects. For these, each response was assigned to exactly one of the classifications and all responses used.

As the country and job role questions were free-text responses, these were manually classified into the best matching categories for display of the results.

2.5 INDIVIDUAL INTERVIEWS

To obtain more nuanced input from key stakeholders, a series of 6 targeted individual interviews were also conducted. Details of interviewees are given in **¡Error! No se encuentra el origen de la referencia.**. The interviews were a semi-structured discussion over a period of about 30 to 40 minutes. They covered a range of topics including background on the project and proposed tools, potential use cases and requirements, and other comments they had regarding the project and proposed tools.

TABLE 2.1: DETAILS OF INDIVIDUAL KEY STAKEHOLDERS INTERVIEWED

Ref.	Stakeholder	Category
Stakeholder i-1	Managing Director for a renewables business consultancy	(i)
Stakeholder i-2	Managing Director for a regional government funding body	(i)
Stakeholder ii-1	Founder of a wave energy device developer	(ii)
Stakeholder ii-2	Engineering Director at a tidal energy device developer	(ii)
Stakeholder iii-1	Senior Business Development Manager for a marine test site	(iii)
Stakeholder iii-2	Senior Renewable Energy Engineer at a consulting engineering firm involved in project development	(iii)

In addition, follow-up interviews were conducted to clarify the responses given by a number of the questionnaire respondents, all of whom had indicated they were willing to participate in a further interview. It was not possible to arrange an interview with a stakeholder from category (iv) Policy makers, regulators, or standardisation bodies, but these were covered in the questionnaire and follow-up discussion.

These interviews covered the four categories of stakeholders noted in sections 1.1 and 2.4, and were conducted between 26 July and 21 August 2018, either in person, by phone, Skype, or by email (for questionnaire follow-up only).

Comments and responses from these interviews were used both to clarify the interpretation of the questionnaire, and to confirm the numerical results obtained. Key points from the interviews are included within the narrative given for the results in section 3.

3. RESULTS

3.1 USER DETAILS & CLASSIFICATION

There was a total of 66 responses to the online questionnaire. Most of the people responding to the survey (74%) were willing to further engage with the project, of which 71% were happy to participate in a follow up interview. A further six stakeholders were interviewed, although quantitative responses were not sought for the questions plotted in sections 3.2 to 3.6.

Reponses were received from a range of users and organisations. The types of organisation, and user roles within them are shown in figure 3.1 and figure 3.2 respectively, noting that users could select as many as appropriate. These organisations give representation from the four categories of users the consultation was aimed at, as shown in table 3.1. Geographically, responses were received from 12 countries, with the majority from within the EU, as shown in figure 3.3.

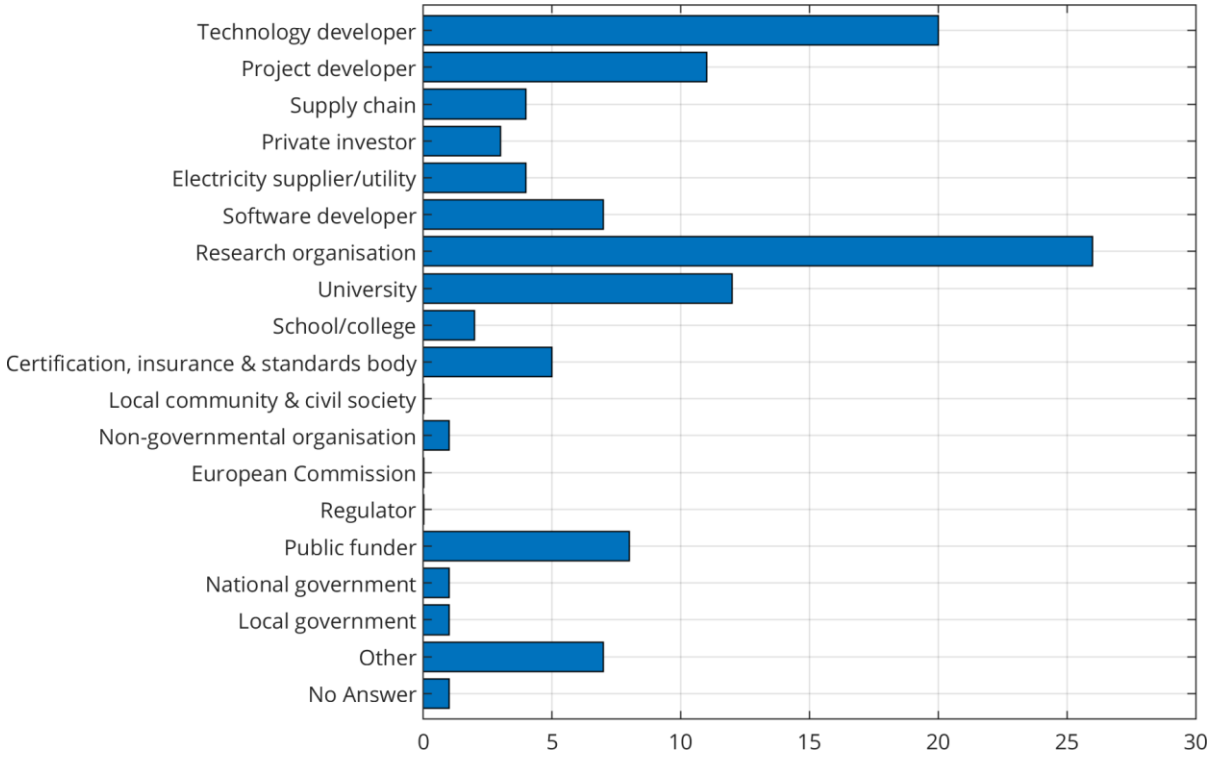


FIGURE 3.1: TYPE OF ORGANISATION (№ RESPONSES)

TABLE 3.1: CATEGORISATION OF ORGANISATIONS RESPONDING

Organisation categories	Number [4]
i) Public funders, commercial investors, and insurance providers	12
ii) Innovators and developers	49
iii) Project developers, utilities, and supply chain	16
iv) Policy makers, regulators, and standardisation bodies	7
Not categorised	2

[4] Note that respondents may fit into more than one category, as detailed in section 2.4.

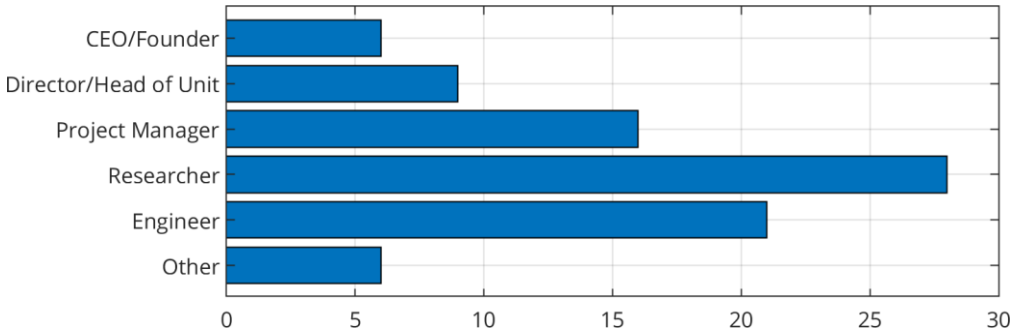


FIGURE 3.2: ROLE WITHIN ORGANISATION (№ RESPONSES)

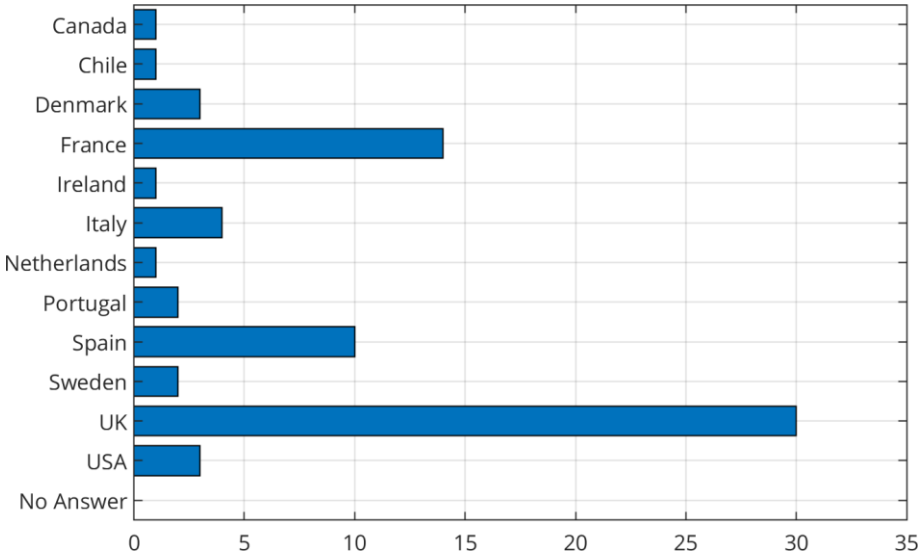


FIGURE 3.3: COUNTRY OF RESIDENCE (№ RESPONSES)

Familiarity with the original DTOcean software was queried, to better understand user responses, with the results give in figure 3.4. The majority of those responding were aware of, but had not used DTOcean. The percentage of respondents that were involved in the original DTOcean project, or are part of the current DTOceanPlus project, in some regard is 17% and 46% respectively, noting that these are not exclusive.

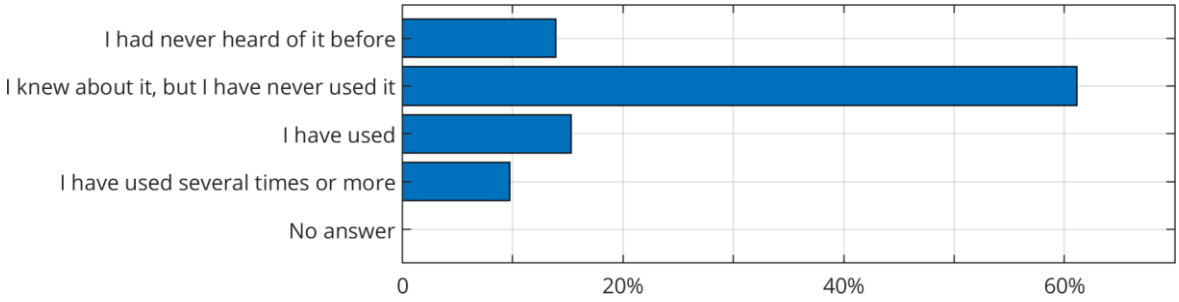


FIGURE 3.4: LEVEL OF FAMILIARITY WITH DTOCEAN

3.2 UNDERSTANDING AND USE OF TOOLS

3.2.1 USE THROUGHOUT PROJECT LIFECYCLE

As discussed in section 1.3, it is planned that the DTOceanPlus software can be used throughout the project life. As such, it is important to understand the use at each of the three stages, in terms of:

- Likelihood of use;
- The balance between speed of computation versus the level of detail of the results in terms of accuracy and complexity;
- The expected duration for data formatting and inputting; and
- Getting training to use the software versus getting a colleague or consultant to assist.

The results are shown in figures 3.5 to 3.9, with stacked bars showing the results from all responses, and pie charts disaggregating these results by the four user categories (noting that users may fit into more than one category, and that not all responses provided organisational data for classification, as detailed in section 2.4).

Q5. How likely are you to use DTOceanPlus for each of the three stages?

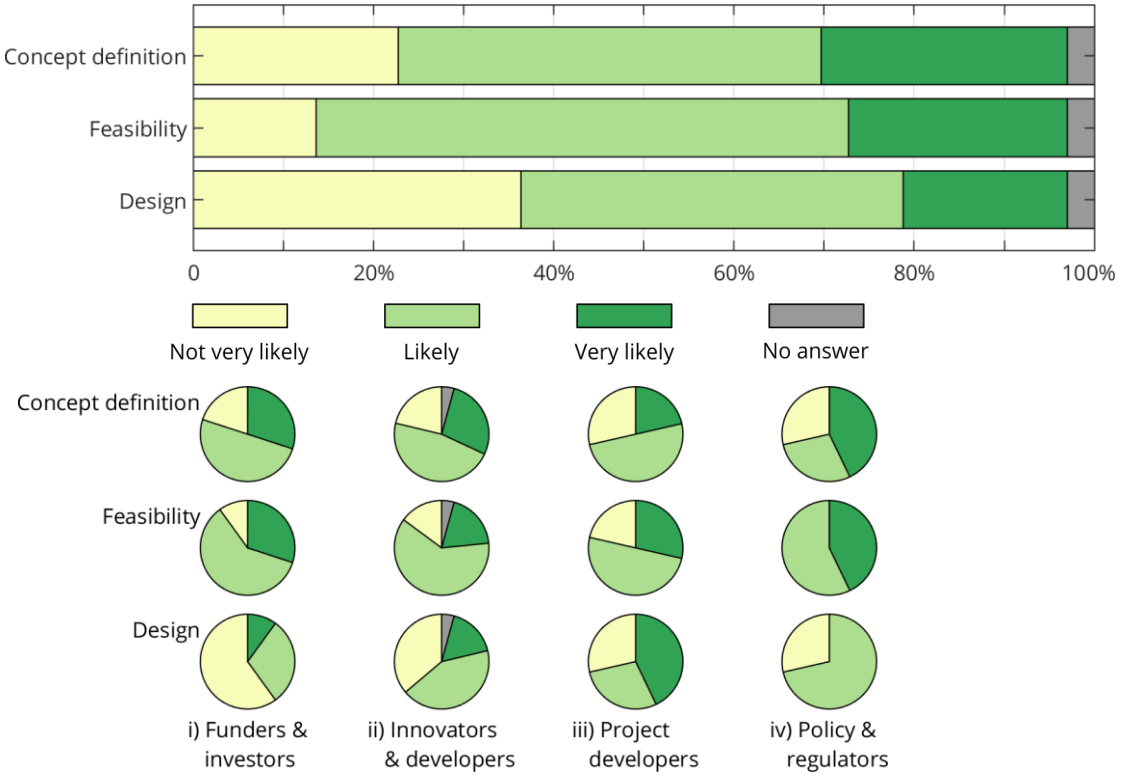


FIGURE 3.5: LIKELIHOOD OF USE OF DTOCEANPLUS AT DIFFERENT STAGES IN PROJECT LIFECYCLE (BARS SHOW ALL RESPONSES, PIE CHARTS DISAGGREGATED BY USER)

Nearly all questionnaire respondents (88%) indicated that they were likely or very likely to use DTOceanPlus at some stage in the project lifecycle, with nearly half (42%) very likely. Several of the respondents queried the naming or number of stages, however it should be noted that the three used were illustrative for the consultation, and may change as the tools are developed.

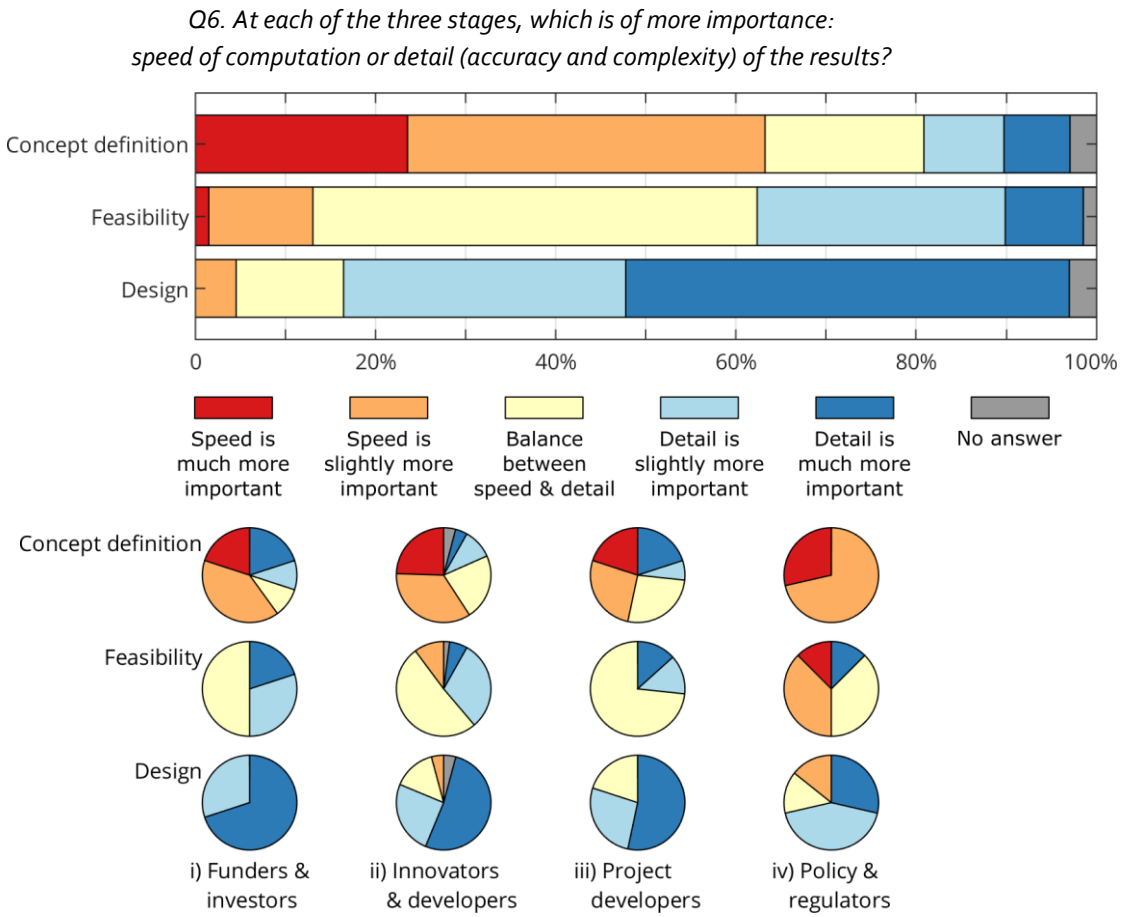


FIGURE 3.6: BALANCE BETWEEN SPEED AND DETAIL REQUIRED AT DIFFERENT STAGES IN PROJECT LIFECYCLE (BARS SHOW ALL RESPONSES, PIE CHARTS DISAGGREGATED BY USER)

The majority of respondents see speed as more important at the concept definition stage, with detail taking more importance at the design stage, as would be expected. A higher percentage of funders and investors expect detail at all stages when compared to the overall sample.

Responses from both the funders and investors, and the policy and regulators groups suggest that detail is much more important at the design stage, although they may not be that likely to use the tools themselves.

Q7. Related to the level of detail needed in the input information to DTOceanPlus, how long would you expect to spend in data formatting and inputting for each of the three stages?
(You can select multiple options if the time range you expect is not specified)

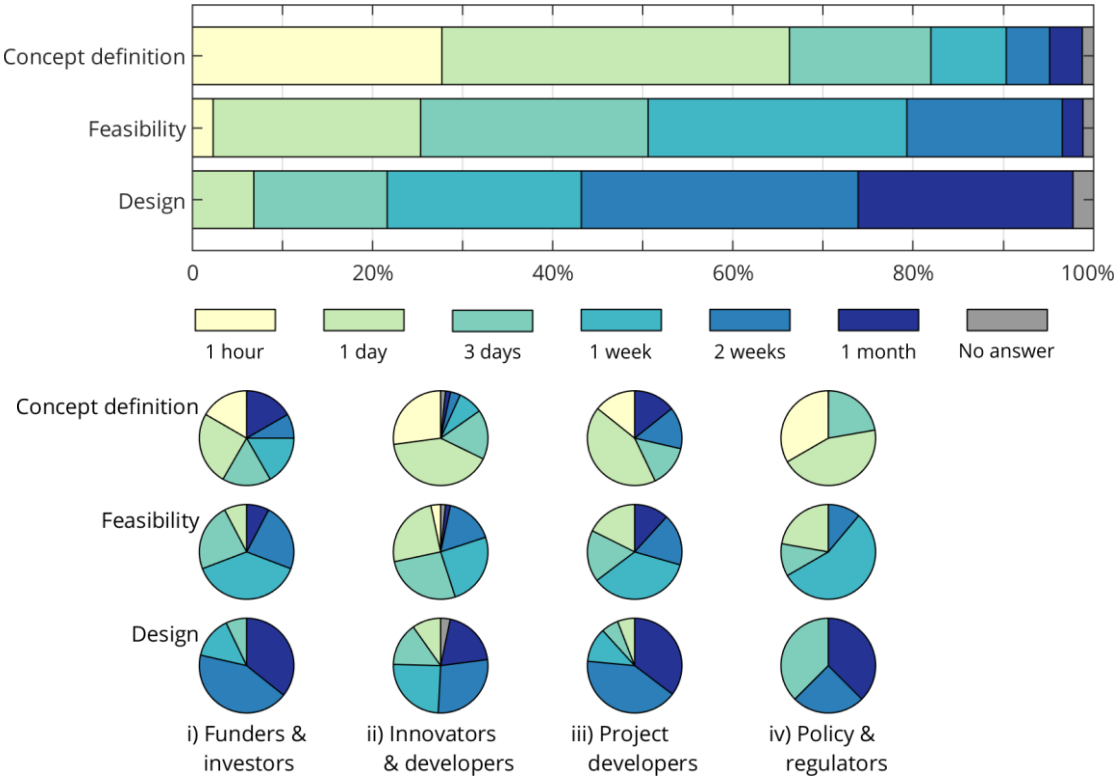
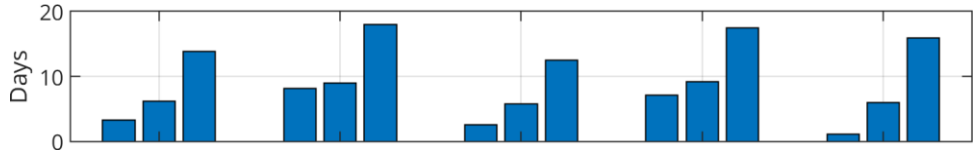


FIGURE 3.7: EXPECTED DURATION FOR DATA FORMATTING AND INPUT AT DIFFERENT STAGES IN THE PROJECT LIFECYCLE (BARS SHOW ALL RESPONSES, PIE CHARTS DISAGGREGATED BY USER)

Similarly to the balance between speed and detail, users expect to spend longer on data formatting and inputting for the design stage compared to concept definition, with feasibility somewhere between. The mean value of the expected duration in days is given in table 3.2, for all responses and disaggregated by user category, for each of the three stages.

TABLE 3.2: MEAN EXPECTED DURATION IN DAYS FOR DATA FORMATTING AND INPUT AT DIFFERENT STAGES IN THE PROJECT LIFECYCLE

Stage	All responses	i) Funders & investors	ii) innovators & developers	iii) Project developers	iv) Policy & regulators
Concept definition	3.3	8.1	2.5	7.1	1.1
Feasibility	6.2	9.0	5.7	9.2	6.0
Design	13.8	17.9	12.5	17.4	15.9



Q8. Thinking about the level of training and experience required to do the data processing and software such as DTOceanPlus. At each of the three stages, are you more likely to get another member of your team or a consultant to assist you, or would you complete training to use the software yourself?

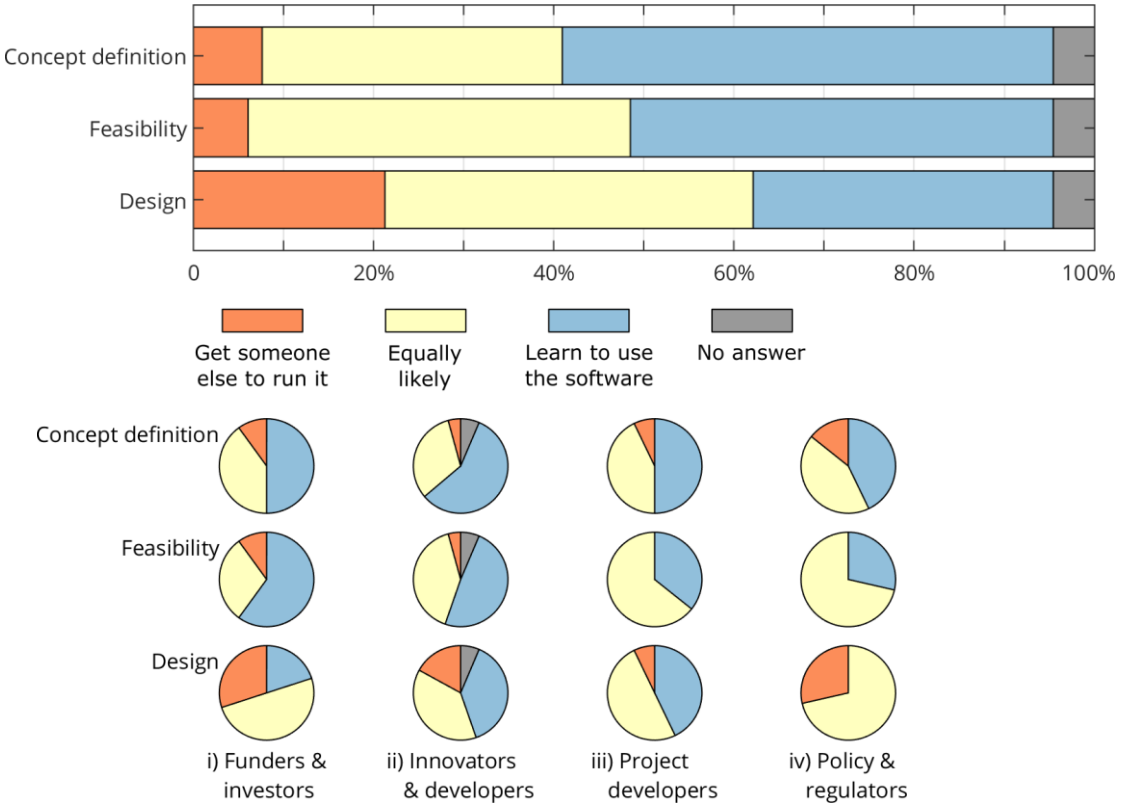


FIGURE 3.8: TRAINING OR ASSISTANCE TO USE DTOCEANPLUS AT DIFFERENT STAGES IN PROJECT LIFECYCLE (BARS SHOW ALL RESPONSES, PIE CHARTS DISAGGREGATED BY USER)

Policy makers, regulators, and standardisation bodies are more likely than others to expect to get assistance to run DTOceanPlus. This is also the case for all groups of users at the design stage, which is likely to be more complex and time consuming.

3.2.2 USE OF INDIVIDUAL TOOLS

The level of understanding of what each of the tools (Structured Innovation, Stage Gate, and Deployment & Assessment) will do on a conceptual level was assessed using three options, as shown in figure 3.9. From this, it is apparent that the Structured Innovation tool was least understood. The Deployment & Assessment tools are most well understood, which may be because these build on the existing DTOcean tools, which some users already know. Respondents may also be familiar with the stage-gate process, as this is used within the sector by WES and is commonly used in mature sectors such as aerospace.

Nearly a third (29%) responded that they understood (conceptually) what the tools would do, with less than a fifth (18%) stating they didn't really understand what all the tools would do.

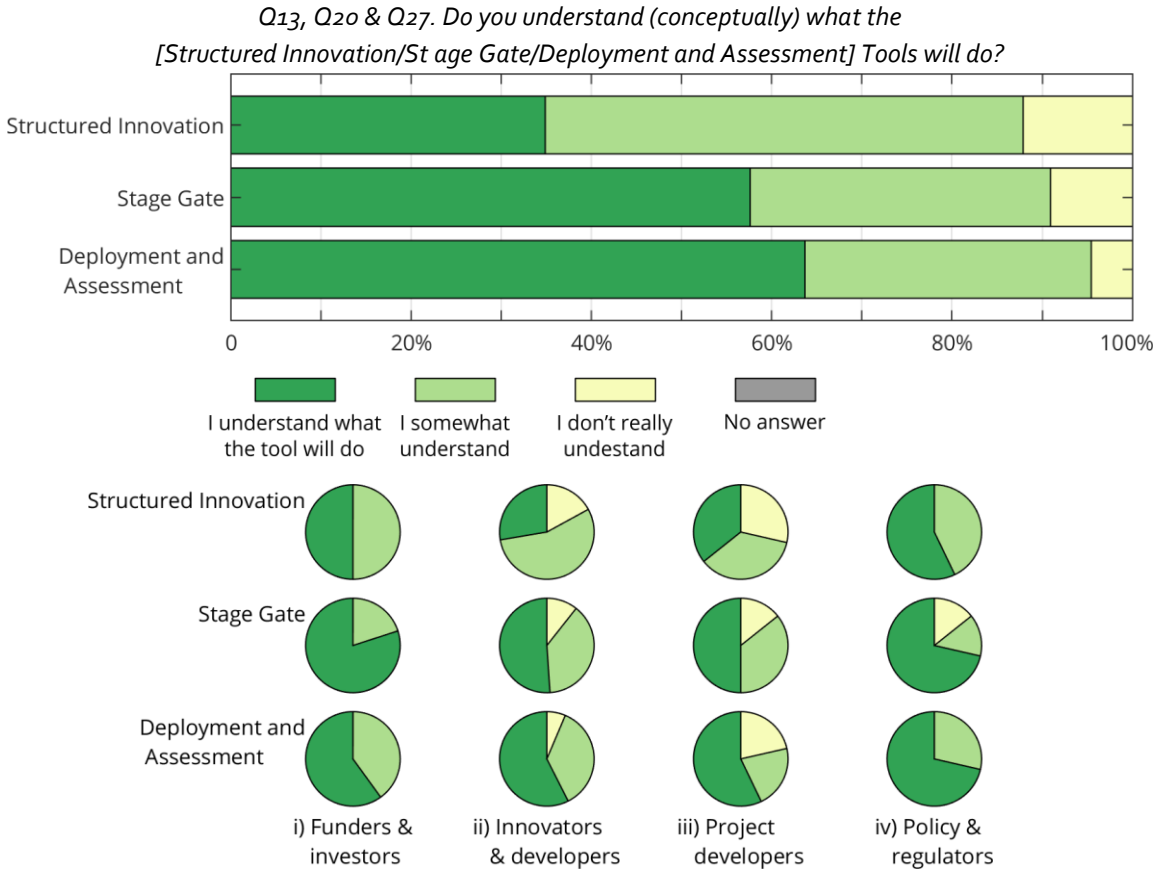


FIGURE 3.9: UNDERSTANDING OF DTOCEANPLUS TOOLS (BARS SHOW ALL RESPONSES, PIE CHARTS DISAGGREGATED BY USER)

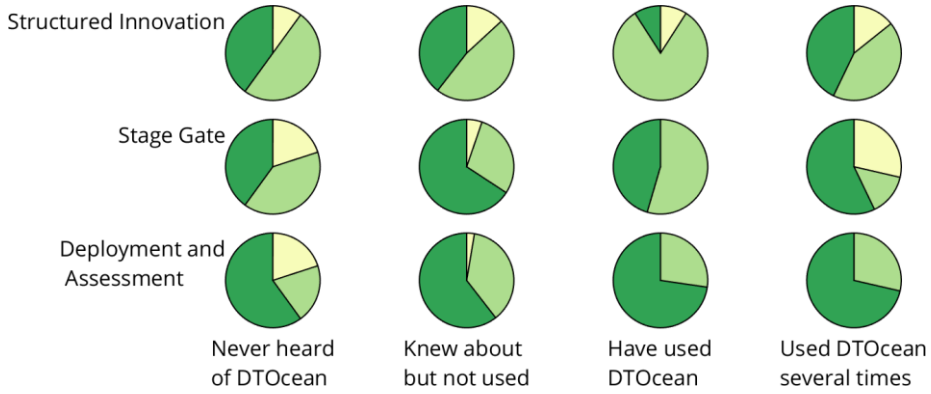


FIGURE 3.10: UNDERSTANDING OF DTOCEANPLUS TOOLS (DISAGGREGATED BY USE OF DTOCEAN)

The propensity to use the each of the tools (Structured Innovation, Stage Gate, and Deployment & Assessment) was also assessed using three options, as shown in figure 3.11. This is also disaggregated in figure 3.12 by knowledge of the original DTOcean project, and by whether the respondent was/is part of the DTOcean or DTOceanPlus projects.

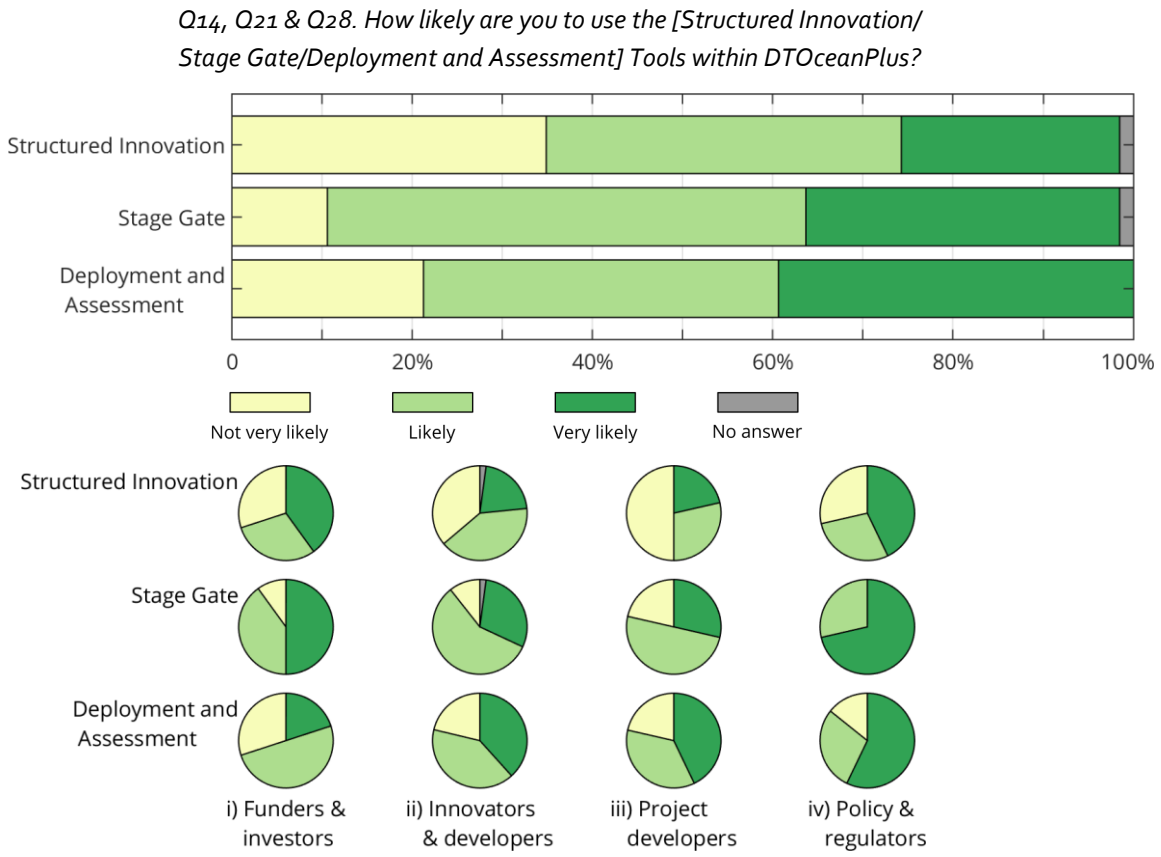


FIGURE 3.11: LIKELIHOOD OF USING THE DTOCEANPLUS TOOLS (BARS SHOW ALL RESPONSES, PIE CHARTS DISAGGREGATED BY USER)

Project developers are less likely than other categories of users to want to use the Structured Innovation tools. The respondents that had used the DTOcean software were most likely to want to use the Deployment and Assessment Tools, i.e. the improved version of what they have used before. There was a fairly even split of likelihood of using each of the tools amongst those that had never heard of DTOcean before.

Several of the stakeholders interviewed suggested it is difficult to know how likely they would be to use the DTOceanPlus tools at this early stage, as the definition is still quite abstract. Stakeholder ii-1 suggested that the Structured Innovation tools may not be that useful to companies like theirs developing wave-energy devices, as these tend to be founded on a specific concept, and don't have the resources to consider lots of alternatives. However use of Structured Innovation at a sub-system level may be more useful, particularly QFD.

The tidal developer, Stakeholder ii-2, explained that their company is most likely to use DTOceanPlus for the later stages of the development process, predominantly the Deployment & Assessment tools, as they have a developed technology that they now want to deploy at larger array scale.

Unsurprisingly, members of the consortia developing DTOcean and DTOceanPlus are more likely to use the software than other respondents, particularly for the small number that were part of both projects.

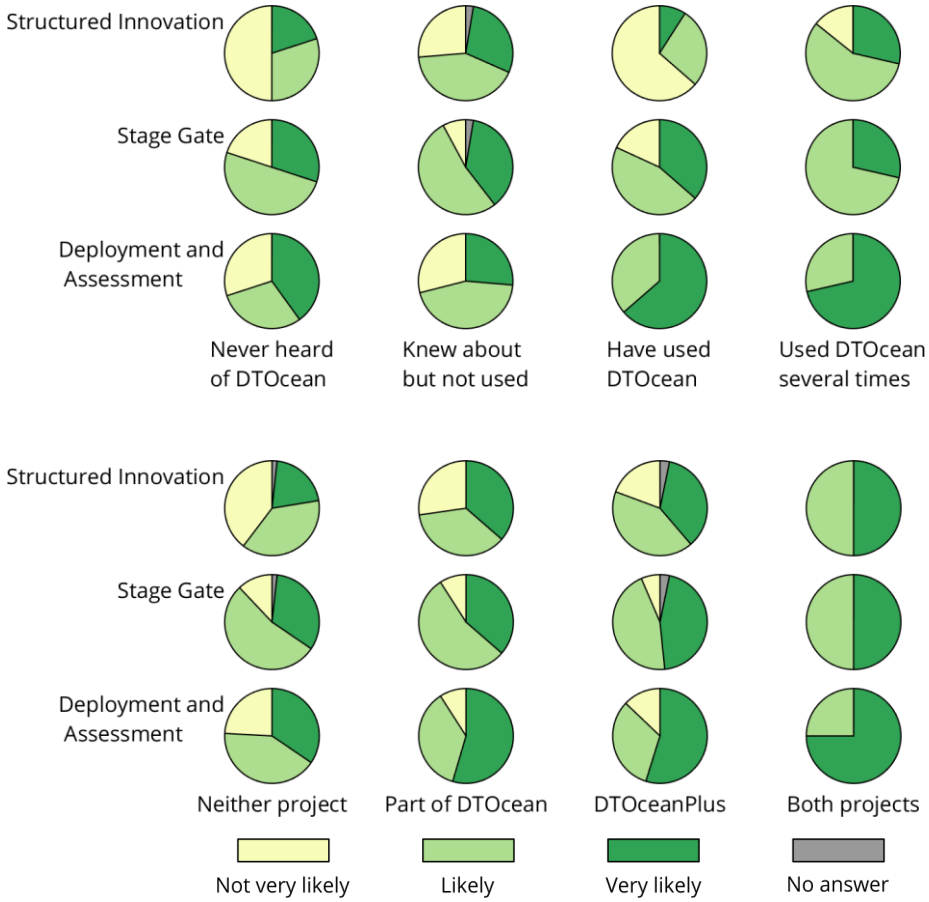


FIGURE 3.12: LIKELIHOOD OF USING THE DTOCEANPLUS TOOLS (DISAGGREGATED BY USE OF DTOCEAN AND BY INVOLVEMENT IN PROJECTS DEVELOPING DTOCEAN AND DTOCEANPLUS)

3.3 IMPORTANCE OF VARIOUS ASPECTS IN DTOCEANPLUS

The importance of various aspects in DTOceanPlus and its constituent tools could be ranked on a five-point Likert scale, from extremely to not-at-all important, as shown in figure 3.13. It is noted that individual responses to these rankings may differ slightly, however the overall trends should be representative.

For those respondents that expect to use the DTOceanPlus software themselves, the importance of a general range of issues were queried. These were: usability; modularity; flexibility and expandability; and portability of the software tools.

Usability was highlighted as a key requirement by Stakeholder i-1, "if the DTOceanPlus software is not instinctively usable, the take up will be limited… other quantities are not as important". They also highlighted that the tools should build on existing software and methods, so that users (e.g. technology developers) are not having to convert to a new assessment system. Stakeholder iii-2 agreed that usability was extremely important, and explained that the code behind DTOcean was very complex, and it was too difficult to use without training. Making the DTOceanPlus software more usable would increase use and decrease the requirements for training.

Q9. If you will be using the DTOceanPlus tools yourself, how important are the following characteristics?

- ***Usability**: How easily the user can learn to operate, prepare inputs for and interpret outputs of the software.*
- ***Modularity**: Degree to which the software is composed of discrete components that can work independently.*
- ***Flexibility & expandability**: How easy is it to adapt, expand or upgrade software capabilities to fulfil specific user needs.*
- ***Portability**: Device independence, degree of which the software can be installed in another machine/operating system.*

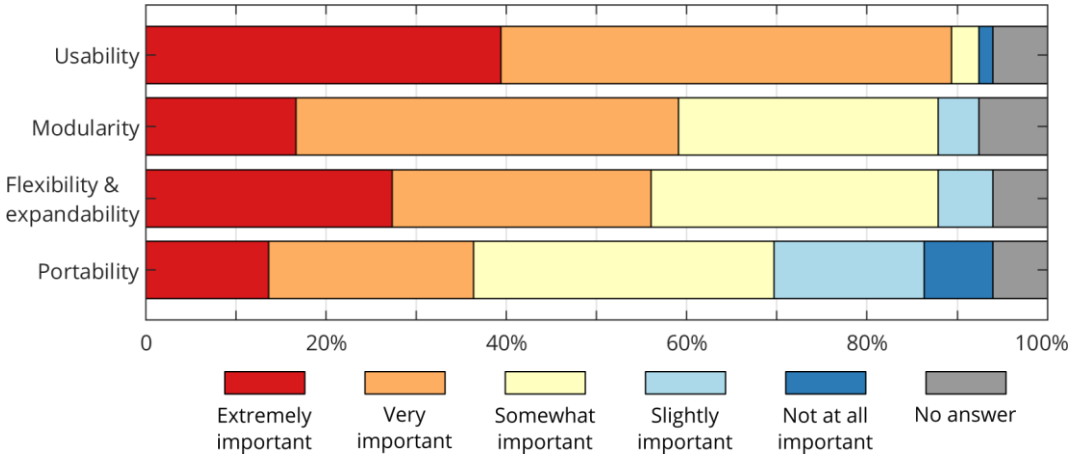


FIGURE 3.13: IMPORTANCE OF GENERAL ASPECTS RELATING TO DTOCEANPLUS

Stakeholder ii-2 noted that the most important aspect for the software would be transparency in how it runs. They explained that it can be very difficult to trust complex tools, whether they are validated or not. Even an expert user might not spot errors, especially when the results are only slightly wrong. If the inputs are of low quality, so will be the outputs. They also suggested that usability of the software can help with learning to run the model and trust the outputs, while modularity of the tools would allow them to be tested and validated independently. Expandability would also be useful if this allows linking to other software, this is discussed further in section 3.7.3. Portability of the software was however not seen as a particularly important issue for their company, as they would typically just be running the software on an office computer.

A certification body employee noted that from "a research point of view, simple independent bricks/modules to be used without GUI may also be an interesting feature" i.e. having a high degree of modularity.

The DTOceanPlus software will incorporate digital representation, a standard framework for the description of sub-systems, devices and arrays. This will be used both as a communication method for the various tools, and can also provide a common language for the entire sector. There may be one or more types of digital models to represent different types of sub-system, device or array, stages in the development process, and levels of complexity as the project develops. Question 11 was to gauge the importance or otherwise of using a single model to represent all of these. The results in figure 3.14 suggest that all of these are of similar importance for potential users of the software.

Q11. How important to you that the same digital representation can be used for:

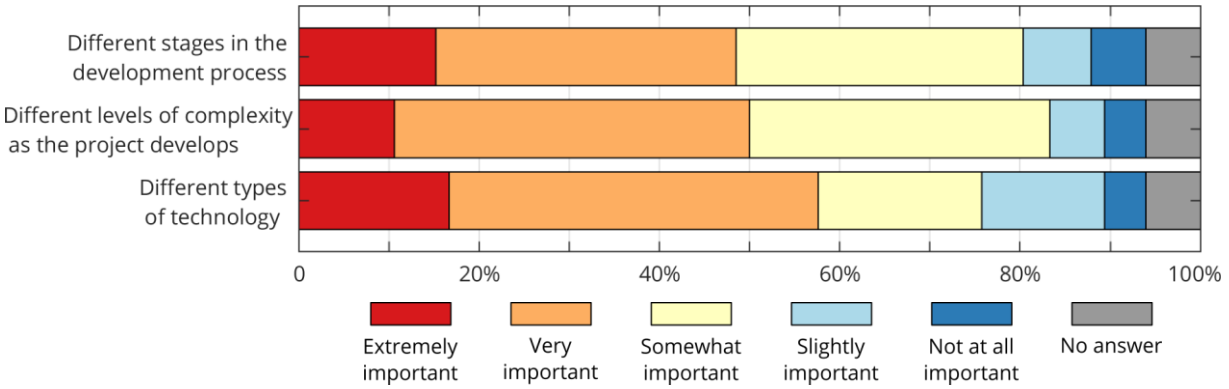


FIGURE 3.14: IMPORTANCE OF USING THE SAME DIGITAL REPRESENTATION

The importance of using each of the tools at different levels of complexity, i.e. considering sub-systems, single devices, and arrays of devices, is shown in figure 3.15. For both the Structured Innovation and Stage Gate tools, the highest importance was placed on device level innovation and assessment, although still important for sub-system and arrays. Using the Deployment & Assessment tools for arrays was ranked slightly more important than for devices, with both more important than use for sub-systems.

Q15, Q22 & Q29. How important is it for you to [...] at the following levels?

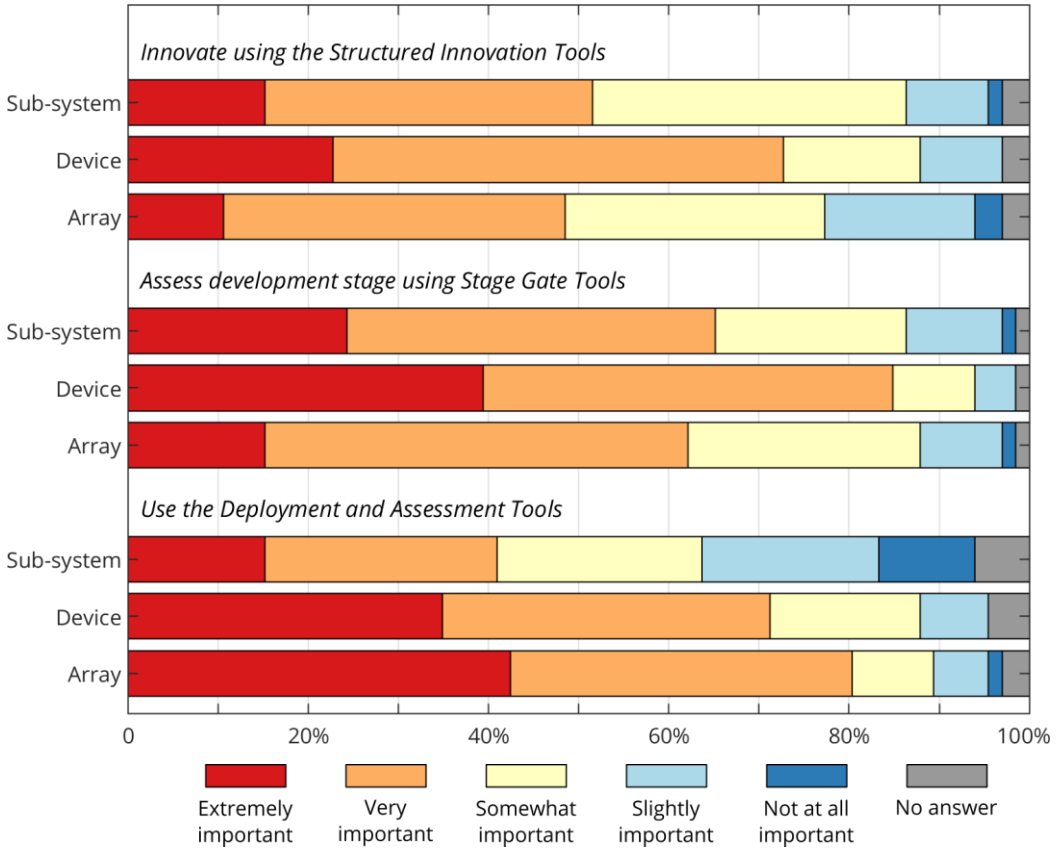


FIGURE 3.15: IMPORTANCE OF USING THE DTOCEANPLUS TOOLS FOR VARIOUS LEVELS

3.4 STRUCTURED INNOVATION TOOL

This section deals with questions specifically on the Structured Innovation Tools. As shown in figure 3.16, users had a slight preference for using these tools for more general problems. Figure 3.17 shows the importance of using the Structured Innovation Tools for various characteristics. Results for design of funding calls have been disaggregated by user category, as >40% of respondents ranked this as only slightly or not-at-all important.

Q16. Which one of the following would you most expect to obtain from the Structured Innovation Tool?

- *Answer to specific problem. Short-term solution and path to reach next level.*
- *Answer to general problem. Long-term solution and path to reach final goal.*

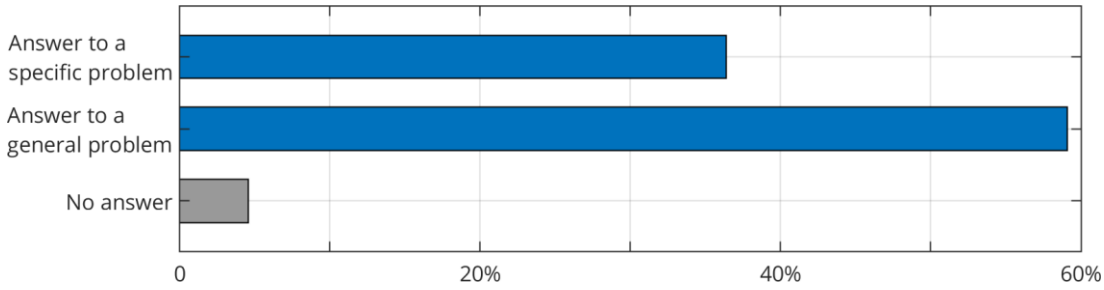


FIGURE 3.16: USE OF STRUCTURED INNOVATION FOR SPECIFIC OR GENERAL PROBLEMS

Q17. How important is it that you can use DTOceanPlus to assess the following characteristics?

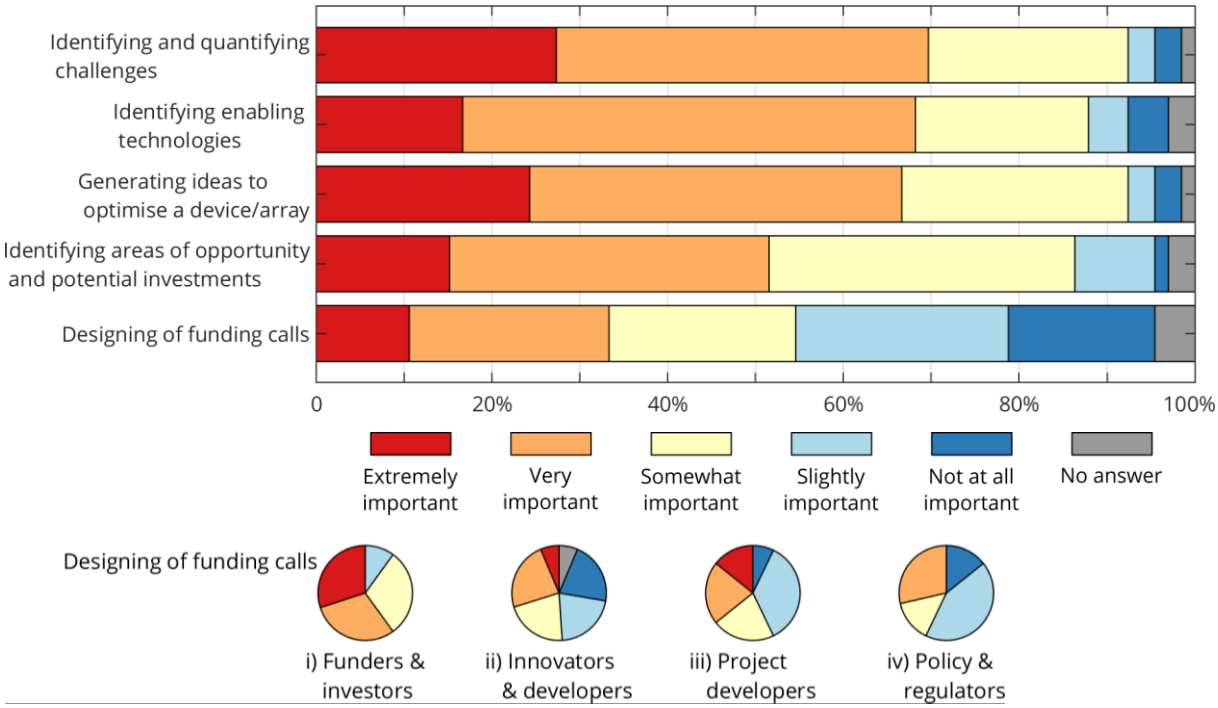


FIGURE 3.17: IMPORTANCE OF ASSESSING CERTAIN CHARACTERISTICS USING STRUCTURED INNOVATION TOOLS (BARS SHOW ALL RESPONSES, PIE CHARTS DISAGGREGATED BY USER)

A few of the respondents specifically commented that they would like to understand more on how the Structured Innovation Tools could be adapted for the ocean energy industry, and how they will be implemented within the software. This included enquiring about evidence of the efficacy of the Structured Innovation Tools applied to immature technologies such as ocean energy. Insight into the assumptions made within the tool is also important.

Other comments on the Structured Innovation tools included:

- "Practical ways of selecting solutions to a technical problem. Linking to experiences and where this has been done before successfully and conversely to avoid the same mistakes being repeated." – Research organisation employee
- "These tools are suitable for identifying potential successful ideas. Thus very important to those making decision on investing or funding. Probably the difference to use these tools from other existing innovation tools would be the in-built provision of clear constraints/targets/relations that would lead to an acceptable/successful LCOE range. All that related to renewable energy success criteria." — Certification body employee.
- "...in term of certification the projects and technologies [innovation] must be in conformity with existing rules and standards. If the innovation or solution proposed is not corresponding to any standard, it will add work for the developers." — Certification body employee.
- It is important the tool has the flexibility to select/change the requirements based on developer needs, including adding custom requirements. — Wave energy device developer (Stakeholder ii-1)
- "The structured innovation tool is valuable as it will be flexible for users to innovate within their specific area of interest... but ...there will be some user intervention at steps along the way ... I don't think it's possible for the whole tool to be fully automated but it will provide guidance and clarity." — Research engineer
- "From my perspective as a technology developer, I'm more interested in tools that prompt me to ask the right questions rather than something that suggests definitive answers. The tool might take the form of a guideline, a methodology or a checklist." — Device developer
- "For the elaboration of due-diligences reports and roadmaps, it is essential to rank the technologies in a comparable manner and present a list possible of scenarios and enabling technologies" — Head of unit at a research organisation
- "The level of detail should be appropriate to steering strategy and technology development opportunity rather than detail concept design" — Senior innovation engineer. A follow discussion clarified this as meaning users need to understand that the Structured Innovation tools should be used to identify areas for further investigation, rather than be seen as a design tool.
- "Also, for successful innovation, there needs to be a focus on business capabilities, and not just on the technology. Innovation is about making money from good ideas, but TRL tells you nothing about the ability of a business to commercialise an invention." — Device developer
- Design of funding calls is only a nice to have as it can be inferred through the outputs of points 1, 2, & 4 (identifying...).

Common organisational requirements for the Structured Innovation tools were:

- Stimulating thought and generation of intellectual property (IP).
- Comparative assessment of innovation potential versus technical risk (for different technologies).
- Risk mitigation.
- Highlighting areas for innovation and other research topics.

3.5 STAGE GATE TOOL

This section deals with questions specifically about the Stage Gate Tools. Figure 3.18 shows the importance of assessing development stage of a wide range of aspects, most of which were seen as very or extremely important by the majority of respondents. The relatively lower importance for the social and environmental aspects is discussed in section 3.7.3. It is worth noting that there is not much difference in importance ranking between the five use cases suggested, lower part of figure 3.18

Q23 & Q24. How important is it for you to assess development stage for the following aspects (using the DTOceanPlus Stage Gate Tools)?

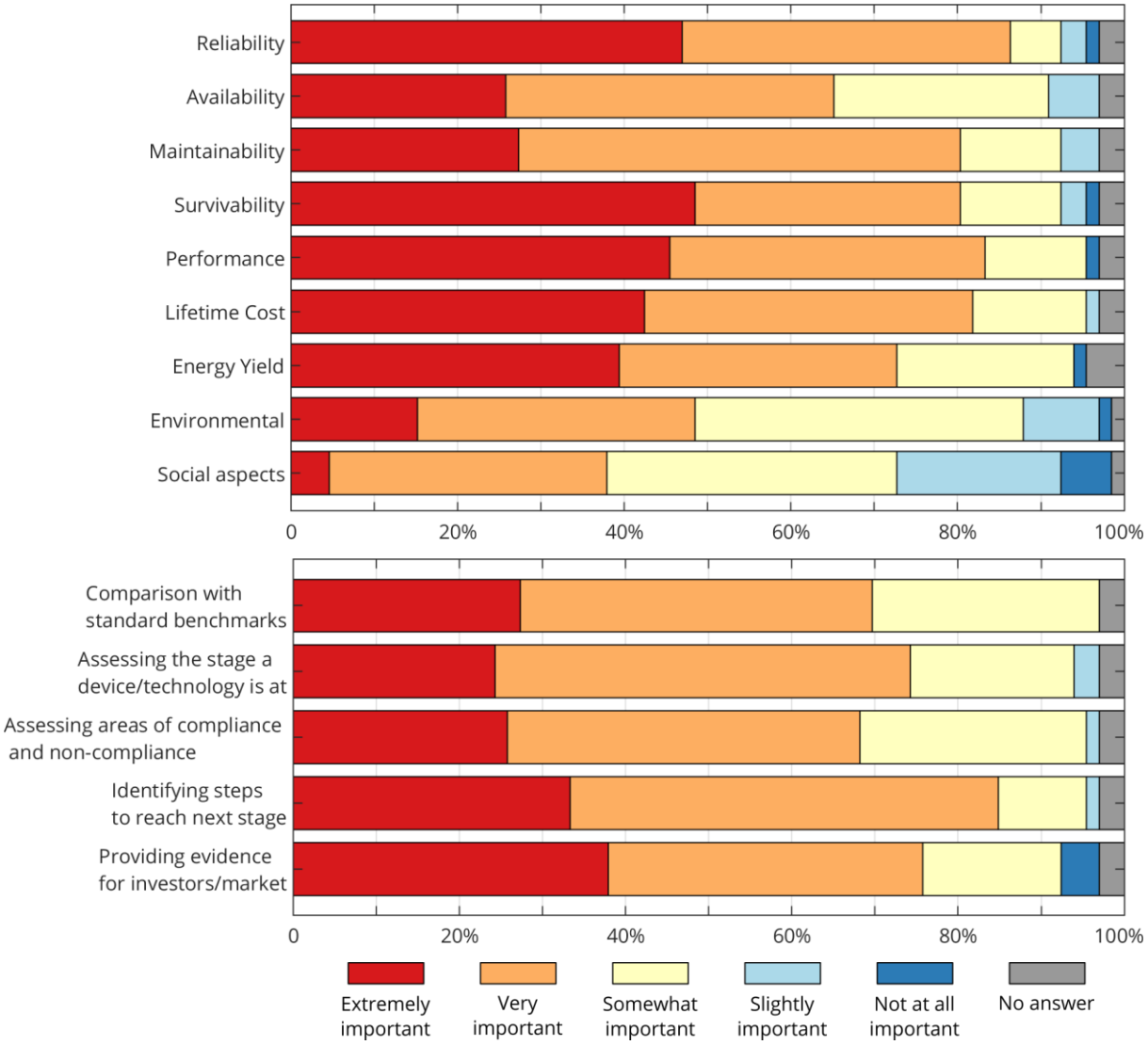


FIGURE 3.18: IMPORTANCE OF ASSESSING DEVELOPMENT STAGE FOR CERTAIN ASPECTS AND USE CASES USING STAGE GATE TOOLS

It was suggested that the benchmarks used for comparison need to be flexible and not favour any specific technologies. When allocating public funding, these bodies need to be very careful to be fair and unbiased, so having a standard tool should assist with this. Making the Stage Gate Metrics & Tools open-source would allow everyone to have equal access.

Flexibility was also highlighted as being important for the Stage Gate tool by stakeholder ii-1, noting that some metrics are more useful than others, and they use other metrics internally. Reliability is also a difficult metric to calculate/estimate for devices at the concept stage. They thought it important to show research on how the metrics used at an early stage link to the commercial stage, and justify the metrics used in DTOceanPlus with citations of other research.

For the Stage Gate Tools, several responses noted that detailed definitions of each of the stages/gates are required. This could also include a check list of relevant stage gate metrics. It was also suggested that the aspects listed appeared to be "inconsistent, overlapping and incomplete", therefore a complete list of aspects for which metrics are required should be developed at the start of the project. It was also noted that "Efforts should be made for the standardisation of these metrics internationally".

It was highlighted that international standards [for offshore renewable energy] are not very developed and need to be updated frequently. If these are included, this needs to be flexible so that it is very easy to modify the different parameters.

Other pertinent comments on the Stage Gate Tools included:

- "I think users should be clear that the tool won't provide detailed answers on complex processes, for example survivability. … Only detailed design and testing will highlight failure modes" — University researcher.
- As well as assessing TRL, it is important to be able to assess how development is progressing at different times during the lifetime of a project, i.e. to show the progress that has been achieved in a particular work package. This is useful to highlight progress for funders etc. — stakeholder ii-1
- "The most important function of the Stage Gate Tool is to provide evidence to investors/markets. If you don't have evidence, then the technology is only really 'an engineer's playground', but it is not worth developing commercially." — Stakeholder i-1

The specific aspects different organisations would like to achieve from the Stage Gate Tools were:

- "Comparison with standard benchmarks."
- "Assessing areas of compliance and non-compliance."
- "Using the Stage Gate Tools as input to our whole-system modelling tools."
- "To quickly find concepts that meet our strategic goals."
- "Supporting developers by identifying the TRL and where should they focus their effort on R&D."
- "Estimations of lifetime costs based on environmental conditions (associated fatigue and operations/maintenance costs)."

3.6 DEPLOYMENT AND ASSESSMENT TOOLS

This section deals with questions specifically about the Deployment and Assessment Tools. Figure 3.19 shows that comparing devices, locations, and combined arrays are all important. Slightly more respondents ranked comparing locations are extremely or very important, which may be skewed by the high number of device developers responding. Stakeholder ii-1 highlighted that it is important to be able to assess combined arrays of different devices and technologies. "Ultimately, wave and tidal technologies are unlikely to be installed alone", but are more likely to form part of a hybrid system combined with storage and other generation methods.

Figure 3.20 then shows the importance ranking for using the Deployment and Assessment Tools to assess various aspects and characteristics of a project. Again, the relatively lower importance for the social and environmental aspects is discussed in section 3.7.3.

Stakeholder i-2 noted the most important tools will depend on who is using them and at what stage, but ultimately the energy yield is key, as this is what funders and investors are going to ask about. It is also important to build up a portfolio of evidence, both for funding and also for eventual certification of the technology. Therefore it is important to involve certification bodies in the development of DTOceanPlus.

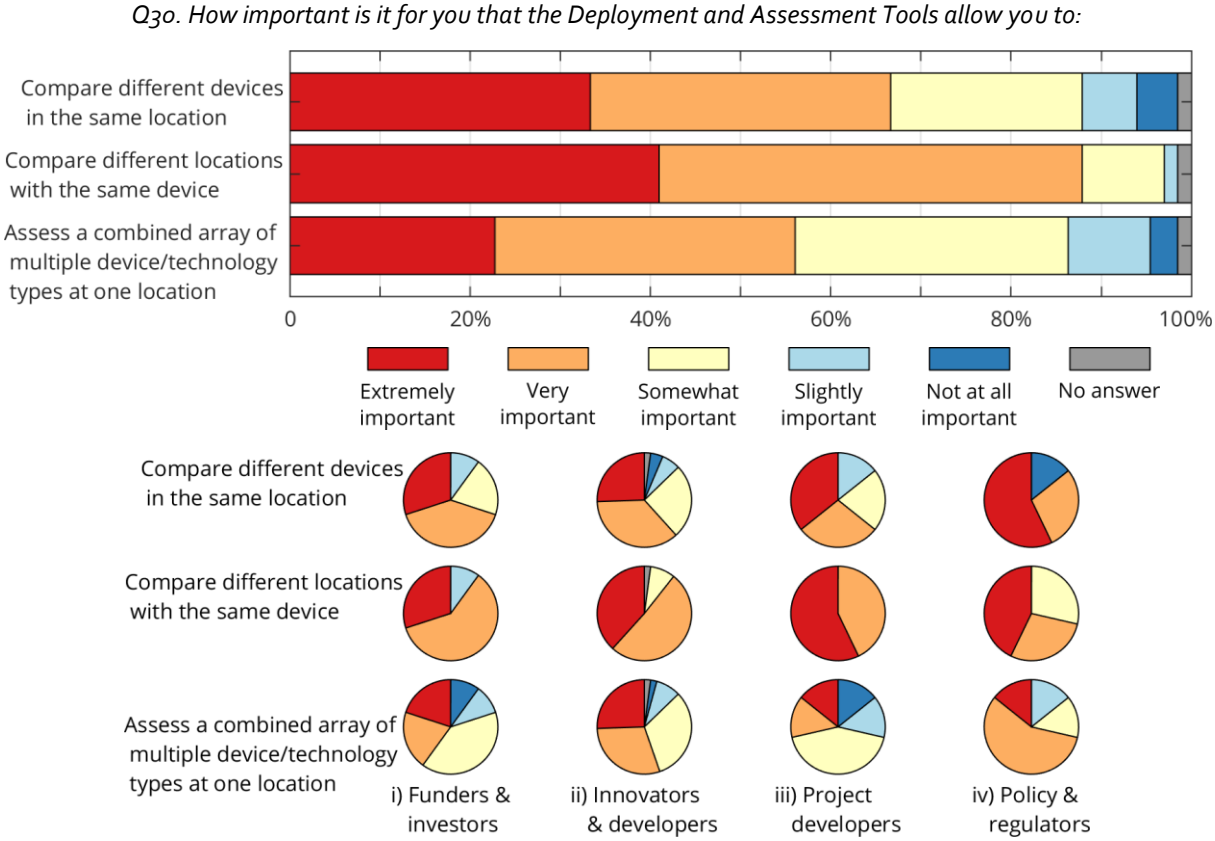


FIGURE 3.19: IMPORTANCE OF ASSESSING DEVICES/LOCATIONS USING DEPLOYMENT AND ASSESSMENT TOOLS (BARS SHOW ALL RESPONSES, PIE CHARTS DISAGGREGATED BY USER)

Q31 & Q32. How important is it for you that you can use DTOceanPlus to assess the following [aspects/characteristics] of a project?

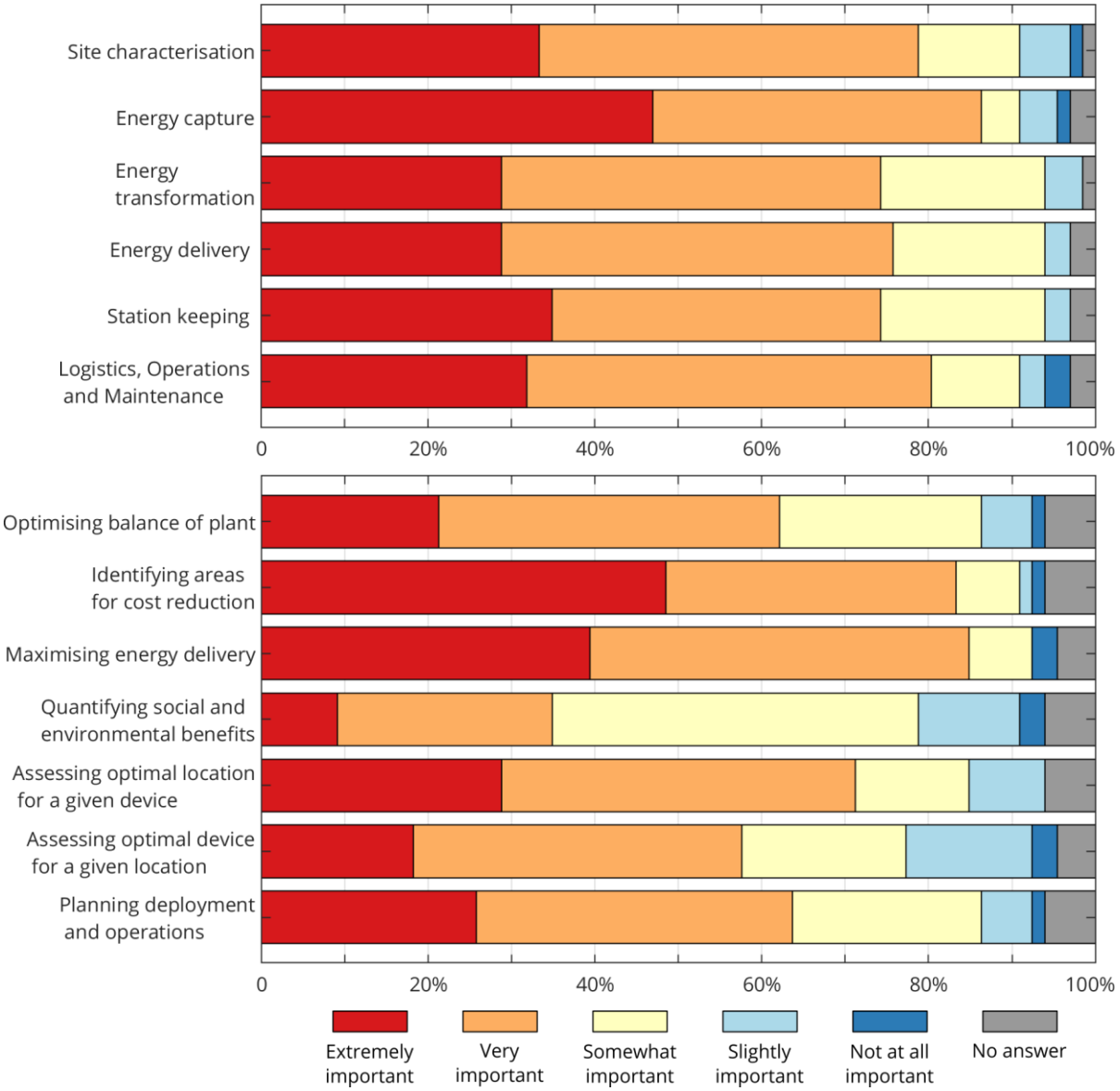


FIGURE 3.20: IMPORTANCE OF ASSESSING VARIOUS ASPECTS/CHARACTERISTICS USING THE DEPLOYMENT AND ASSESSMENT TOOLS

Stakeholder iii-2 suggested that the focus for DTOceanPlus should be more on technologies and devices than arrays. They advocated against spending more money developing new array tools, as the wave and tidal energy sector is not at the stage of developing array projects.

A tidal device developer provided detailed feedback in the survey, highlighting the complexity of the task. They suggest focusing on guiding towards the right questions to be asked, rather than trying to develop tools to provide definitive answers to technical questions.

> *"There is huge variety between potential technologies and sites. There is also very little experience in planning and delivering ocean energy projects. Project development is extremely*

complex, requiring developers to take account of a huge array of technical, commercial and environmental factors. And there are huge uncertainties facing all stages of project development. These considerations make it very challenging to design generic tools that will be widely used by the emerging industry – probably impossible. The kind of tool that would be widely useful is a set of tools that step through the stages of project development. From identifying a project, to selecting a technology, gaining leases and consents, securing finance, developing the site, constructing the project, operating the array and decommissioning. There are common factors to consider at all these stages which are not project or technology specific, and can usefully be codified into a set of guidelines. I'm not convinced that it's possible to develop quantitative tools that can provide definitive answers to technical questions – the task is just too complex. What you can do is guide developers to ensure they are asking the right questions, and to provide them with or point them towards resources to help them to answer those questions."

Other comments on the Deployment and Assessment Tools included:

- The "DTOcean environmental assessment module is currently based in scores for different affected areas. Another approach I would like to see is the environmental impacts focused on CO_2 emissions (based on my experience that would be a more industry based approach)." — University researcher.
- "It would be great if long term resource assessment data could be imported".
- "The optimum array designed should consider the minimization of LCOE and not only maximization of AEP value".
- "Optimisation of energy yield using OpenFOAM must be prioritized for wave energy to catch up to tidal and wind."
- One questionnaire response noted "There are several sophisticated commercially available tools which do some of the above already e.g. https://www.searoc.com/marine/seaplanner/. Careful thought should be given to addressing the gaps where most value can be added to the sector." This was echoed by stakeholder iii-1, who mentioned they have used JBA ForeCoast Marine and Mermaid by Mojo Maritime/James Fisher for marine operations planning.
- "It would be very nice to assess reliability and availability as early as possible; however it is very difficult to do this before a significant amount of operation hours have been accumulated by a given technology." — Device developer

The specific aspects that different organisations would like to achieve from the Deployment and Assessment Tools included:

- Related to costs and financing
  - Estimations of lifetime costs based on environmental conditions (associated fatigue and operations/maintenance costs).
  - "Identification of cost reduction pathways".
  - "Present investors with the information they need to identify promising technologies and remaining challenges that need to be overcome through further funding and investment".
- Planning installation, operation, & maintenance logistics.
- Support the assessment of technologies in real deployment scenarios.
- A certification body employee was most interested in security issues.
- "Initial assessments only" — University researcher.
- One respondent also noted that "High detail in hydrodynamics is key".

3.7 OTHER REQUIREMENTS AND COMMENTS

3.7.1 LINKAGES BETWEEN TOOLS

Several responses highlighted the need for interlinkages between the tools to form an integrated package.

The Structured Innovation and Stage Gate Tools need to work together closely, as both are involved in the innovation process. This is required at all technology levels: sub-system, device, and array. It is also important to record steps and decisions, and these need to be evidence based. Only once this has been demonstrated as part of the innovation process can the developer meet the stage gate. Stakeholder i-1 highlighted that there is commonality with the process of funders unlocking investment when certain milestones are reached, and that companies need to demonstrate diligence in order to do this.

It was also highlighted that the outputs from the Deployment and Assessment Tools should feed into both the Structured Innovation and the Stage Gate Tools.

3.7.2 DEALING WITH LEVELS OF COMPLEXITY

A number of responses mentioned the difficulty in dealing with varying levels of complexity. This applies both to the amount of data available at different stages in the development of a technology/ project, and to the level of detail required by different users. For example, an investor may want a high-level overview with limited detail, however a technology developer is likely to require as much information as possible. It was also noted as "essential that this tool can be used by different people with different skills (e.g. someone working in site assessment and someone in O&M)".

One comment received was that the "...tools will need to vary by TRL and availability of data. How will these be accessible and useable by specialists in industry and perhaps non-specialist investors? A high-level set of tools for the latter and deeper technical tools for the [former] would be good."

On a similar topic, stakeholder ii-2 discussed several times is that there are significant differences between wave and tidal energy devices. The development requirements for each might be quite different, particularly as there is little consensus on how to extract energy from waves. Stakeholder ii-2 suggested there may be a lower requirement for widespread innovation in the tidal sector compared with wave, as tidal is similar in many respects to the well-established wind industry. For wind, and now tidal, development has consolidated on horizontal axis turbines, with two or three blades, to capture energy from the moving fluid. Modularity of the tools was therefore discussed, with stakeholder ii-2 agreeing that it may be required/best to have versions of DTOceanPlus for wave/tidal with common modules or libraries for topics like grid connection.

3.7.3 SOFTWARE COMPATABILITY AND REQUIREMENTS

The ability to link the DTOceanPlus tools to other software was also highlighted by several respondents. This covered a few different use-cases:

- Importing data from a wide range of sources to be used in DTOceanPlus.
- Exporting results from DTOceanPlus, either to use in another analysis tool or formatted for inclusion in reports.
- Accessing and running analysis from each tool/module independently, as an input to an external software package.
- Incorporating results from other software tools into the global database, so that these can be used within DTOceanPlus. This includes company or device specific code/software routines.

It was also highlighted that it should be possible to both import and export data to and from DTOceanPlus, including in standard formats compatible with many software types, e.g. CSV.

It would be useful to have an API (application programming interface) to connect to and interface with other software tools, as well as the GUI (graphical user interface). For example, stakeholder ii-1 uses their own optimisation routines, programmed in MATLAB, which would be useful to be able to integrate with the other tools in DTOceanPlus. This would let developers make use of the tools, but also have code specific to unique features of their device. The external API may also be the internal means of communication between different parts of DTOceanPlus. It should also be clarified and publicised early in the project if the tools can be used independently.

From the questionnaire and interview responses, there was a wide range of software packages that it was felt DTOceanPlus should be compatible with, which are outlined below. The most requested software for DTOceanPlus to be compatible with was Mathworks MATLAB, most likely as this is a powerful and flexible tool that is used extensively, especially within academia and research organisations.

- **General purpose software used in engineering**, such as MATLAB/Simulink, Python, and Microsoft Excel. Additionally, having compatibility with Microsoft Word for reporting purposes would be useful.
- **GIS/CAD packages** (for geographical data such as bathymetry, and for defining components/ devices) including: ArcGIS, AutoCAD, MicroStation, SolidWorks, etc.
- **Resource characterisation**, including: MIKE21, MIKE3, SWAN, DNV-GL TidalFarmer.
- **Hydrodynamic performances and system simulation**, including: WEC-Sim, Nemoh, DNV-GL TidalBladed, SimulationX, WAMIT, ANSYS AQWA, ANSYS Mechanical, or other FEA software.
- **CFD software**: such as ANSYS Fluent, OpenFOAM, Flow3D, etc.
- **Station-keeping and mooring analysis**, including: Orcaflex, Principia DeepLines, BV Ariane.
- **Operation & maintenance** tools, e.g. the Wave Energy Scotland tool.

It was also highlighted that some form of 'version control' is required to track the various model runs, e.g. which parameters were varied in each run of a sensitivity analysis. It should also be possible to save the input parameters and/or model output to a file, and then easily reload these parameters at a later date without having to manually input all the data again.

One respondent commented that "OpenFOAM is the key tool for the future of hydrodynamics study. You must be compatible with this for every type of hydrodynamic analysis. Other tools such as WAMIT and other linear and frequency domain methods are not good enough."

3.7.4 ENVIRONMENTAL AND SOCIAL ASPECTS

The importance of using DTOceanPlus to assess environmental and social aspects was ranked relatively lower in the survey, as shown in figure 3.18 and figure 3.20. In follow up discussions, the reasons given for this included a number of factors:

- Environmental and social issues are very location dependent, and may be difficult to quantify easily enough to use within a tool. For social issues particularly, these may be better dealt face-to-face, as they can be hard to quantify if not engaged directly with that community.
- Similarly, the DTOceanPlus tools mostly deal with technical-led engineering activities, but social and environmental aspects are very site dependant and involve lots of other skills. It was suggested that this is also well covered by other work.
- "Environmental issues for marine energy deployments have been shown to be not a significant issue at many sites, even though these are important."
- Stakeholder iii-1 noted that it is "difficult to automate the assessment of environmental aspects of a project", although a software tool can possibly assess the likely costs for conducting the required environmental assessments.

3.7.5 MOST USEFUL/VALUABLE PART OF DTOCEANPLUS

At the end of the questionnaire, users were asked what they through the most useful/valuable part of DTOceanPlus for them or their organisation. A project development manager noted that "the most valuable part would be to truly create a dynamic community around the tool so that not only those who have been developing are using it but also a wide and diverse range of other people".

Many of the responses referred to one or more of the tools, or a specific capability thereof, with a fairly even spread of responses across the three tools. Some specific points raised are included below:

- **Structured Innovation Tools**
  - "Structured Innovation tools, since that gives us the opportunity to characterise future development potential and pathways".
  - "Identification of attractive technology development routes using Structured Innovation will allow us to create the best funding calls".
- **Stage Gate Tools**
  - Stakeholder iii-2 suggested the Stage Gate tools were the most important of the three, as "developers need to know when to stop working on a concept that's not going anywhere", particularly in terms of financial viability.
  - "The Stage Gate Design Tool will be the most valuable as … it will support the objective assessment of ocean energy technologies".

- "Coherence, structure and independence in the process of assessing the claims of device developers and reviewing their technology readiness".
- "Comparison and benchmarking with other tools and methodologies in order to reduce uncertainties and gain confidence on design processes".

- **Deployment and Assessment Tools**
  - "Assist on the evaluation of the optimum array design for different sites, considering different modules and inputs".
  - "Proving the bankability of arrays, and having third party input".
  - "The deployment and assessment tool, to compare technologies and develop projects".

The other main areas seen as most valuable were for supporting investment decisions, and the development of standardised tools and methodologies.

3.7.6 OTHER COMMENTS

The key stakeholders interviewed raised a number of other interesting points.

Stakeholder i-1 comes to the marine renewables sector from a funding and finance perspective, and suggested that it is critical to engage with the funding and financial investment communities so that they have buy-in to the tools and methods used to assess technologies and projects. There are many such stakeholders, including those involved at the innovation/R&D stage through to equity investors. There are also a number of venture arms attached to big OEM and oil & gas companies. It would be good to get these organisations involved with the development of DTOceanPlus, as the software needs to work for them and be robust to make grant/equity decisions. It will be easier for these companies to have a high level of comfort in the results if they have been involved with the development of the DTOceanPlus tools. As a closing remark, stakeholder i-1 recommended that it was more important to focus on the needs of funding bodies and investors, as technology developers will want a tool that suits how they work at the moment; however progress in the sector is too slow, suggesting that these methods don't work.

Stakeholder iii-1 highlighted that there may be a perception within the industry that DTOcean is an academic tool, and that it is not market ready.

Stakeholder iii-2 suggested there is a gap in the set of tools, which is the most important issue for the sector, namely identifying a route to market. There is currently a "vicious circle" of pre-commercial projects being too expensive and struggling to get funding, but these are required to reduce costs for future commercial projects. This particularly applies to tidal, but will be applicable to wave as well, both in the UK and internationally. They recommended that the assessment tools should include financing of pre-commercial projects. For example, for a set CAPEX what financial support is required to allow this project to happen? They also suggested that intermediate targets are required for the stage-gate assessment, as the £150/MWh LCOE is too far away.

Additionally, there were number of other comments given in the questionnaire responses relating to the requirements of DTOceanPlus, both as a project and for the software developed.

- Desire for easy to use and robust software:
  - "Software standards are high in industry … The software needs to come with full documentation and tutorials for ease of uptake and use."
  - "Engineers in charge of certification would request a "ready to use software", in order to be easily used in a certification process (without bugs, direct module interactions, etc…)" — Certification body employee
  - "Will you offer a training webinar video [to teach] the software?"
- Automating tasks to allow batch runs or sensitivity analysis is important.
- Further explanation of how the various tools will work needs to be provided as the project progresses, particularly for the Structured Innovation Tools.
  - "It is not clear at this stage how the desired invention and innovation in order to come up with new WEC technology concepts can be implemented in an automated computational way."
- Long-term product security. Will DTOceanPlus be free-to-use software after the project is completed, and if so what is the business model to support it going forward?

4. CONCLUSIONS

4.1 KEY FINDINGS

Stakeholder i-2 summarised that all areas of DTOceanPlus are important—innovation, assessment, and deployment—this will be a tool to give confidence to both public and private investors.

Further work is required during the DTOceanPlus project to explain the functionality and use of the proposed tools, particularly focusing on the Structured Innovation concept as this is less well understood. Additional clarification of the tool's scope would also be beneficial, in terms of stages of the development lifecycle covered, how this links with TRL, and to different points during a project.

As might be expected, speed is more important than detail for most users at the concept definition stage, whereas detail takes precedence for design, section 3.2.1. Users expect to spend approximately three, six, and 14 days on data formatting and inputting at outline, feasibility, and design stages respectively.

Of the overall software characteristics considered, usability followed by flexibility & expandability then modularity were seen as most important. Additionally, transparency of how the tools work is critical, including documentation referenced to background research, and some form of version control or parameter tracking. A high-quality software product is expected of DTOceanPlus, something not all people consider DTOcean delivered.

The proposed tools will need to deal with varying degrees of complexity, both at different stages in the project lifecycle and also for different user requirements. How this will be dealt with was a concern for some. A suggestion was to have 'high-level' and 'technical' tools (or 'simple' and 'expert' modes), exposing more detail in the latter for those who have data and time available to do more analysis.

Several responses stressed the importance of linkages between the tools, and with external software, see section 3.7.3. One technology developer suggested having an API to allow external software and scripts two-way access to the DTOceanPlus tools and data, allowing flexibility to use either DTOceanPlus or another tool as deemed most appropriate.

Assessing environmental and social aspects of a project was seen as a lower priority for many respondents, as discussed in section 3.7.4. There are also several tools available for marine operations planning. DTOceanPlus should instead concentrate on other aspects, to add best value to the ocean energy sector.

4.2 NEXT STAGES

The next stage of the DTOceanPlus development will be to translate the user requirements into detailed functional requirements both for the software as a whole and for the individual tools, which is illustrated in figure 4.1. The next task is T2.2 'analysis of tool requirements and best practices', which will produce report D2.2 'Functional requirements and metrics of 2nd generation design tools'. This will include a review of the state-of-the-art and other tools for the design of ocean energy systems.

Following on from this, the detailed specifications for each of the tools will be developed, in conjunction with developing a digital representation of ocean energy systems. Building on these specifications, the DTOceanPlus software will be developed and validated in stages over the next two years.

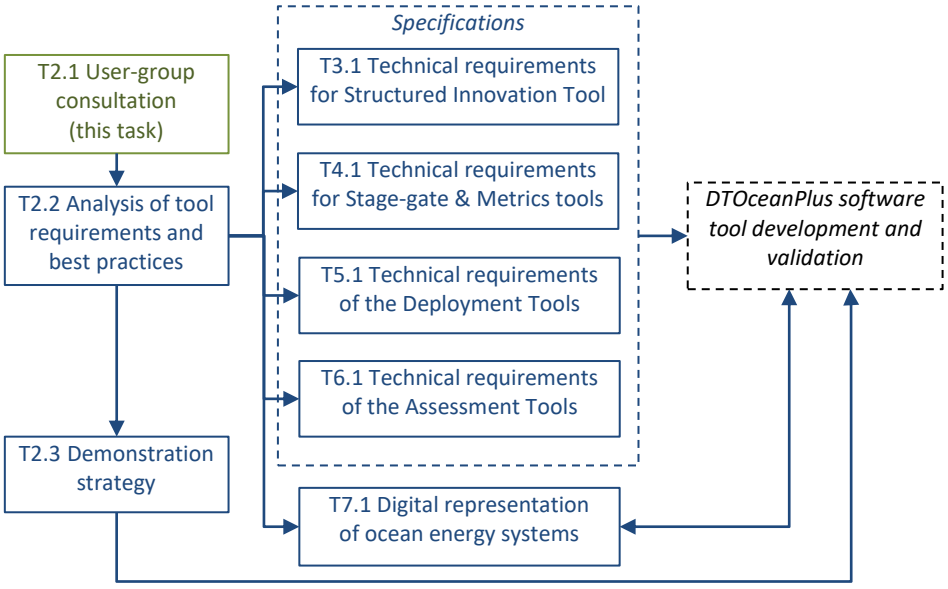


FIGURE 4.1: GRAPHICAL SUMMARY OF SOFTWARE SPECIFICATION TASKS (EXTRACTED FROM GRAPHICAL PRESENTATION OF THE PROJECT [10])

5. REFERENCES

[1] European Commission, "Optimal Design Tools for Ocean Energy Arrays | Projects | FP7-ENERGY | CORDIS," 10 Sept 2017. [Online]. Available: https://cordis.europa.eu/project/rcn/110303_en.html. [Accessed 25 July 2018].

[2] DTOcean, "DTOcean User Manual (Release)," 2016.

[3] European Commission, "Advanced Design Tools for Ocean Energy Systems Innovation, Development and Deployment | Projects | H2020 | CORDIS," 17 January 2018. [Online]. Available: https://cordis.europa.eu/project/rcn/214811_en.html. [Accessed 6 August 2018].

[4] DTOcean, "DTOcean Google group," 2017. [Online]. Available: https://groups.google.com/forum/#!forum/dtocean. [Accessed 24 July 2018].

[5] DTOcean, "GitHub: DTOcean Issues," 2017. [Online]. Available: https://github.com/DTOcean/dtocean-issues/issues. [Accessed 24 July 2018].

[6] Nova Innovation, "EnFAIT Project Overview," 2018. [Online]. Available: https://www.enfait.eu/. [Accessed 24 July 2018].

[7] E. Medina-Lopez and T. Bloise-Thomaz, "EnFAIT D10.3 DTOcean : Scenario Definition & Performance Metrics," EnFAIT Project, Edinburgh, 2018.

[8] E. Medina-Lopez and D. R. Noble, "DTOceanPlus User needs consultation – Introductory webinar," 6 July 2018. [Online]. Available: http://www.dtoceanplus.eu/News/News-events/A-webinar-to-present-DTOceanPlus-to-potential-users. [Accessed 14 August 2018].

[9] Jisc, "Online Surveys," [Online]. Available: https://www.onlinesurveys.ac.uk/.

[10] DTOceanPlus Consortium, "DTOceanPlus Proposal: Advanced Design Tools for Ocean Energy Systems Innovation, Development and Deployment," 2017.

ANNEX I: CONSULTATION QUESTIONS

TABLE I.1 DETAILS OF QUESTIONS INCLUDED IN QUESTIONNAIRE.

№	Question
	Page 1: Introduction & Your Details
1	Electronic consent, I agree to the terms above [Checkbox]
2	Are you willing to provide your contact details to engage further with the DTOceanPlus project? *(Optional)* [Yes/No]
2a	Name [Textbox]
2b	Email [Textbox]
2c	Would you be willing to participate in an additional individual interview (by phone, in person, or email) at a later date? [Yes/No]
2d	Would you like to receive a summary of the findings? [Yes/No]
	OPTIONAL USER CLASSIFICATION INFORMATION You can respond to this survey anonymously, but any details you provide will help us to further understand our users.
3	What type of user/organisation are you responding on behalf of? *(Please select as many answers as appropriate)* ▫ Technology developer ▫ Project developer ▫ Supply chain ▫ Private investor ▫ Electricity supplier/utility ▫ Software developer ▫ Research organisation ▫ University ▫ School/college ▫ Certification, insurance & standards body ▫ Local community & civil society ▫ Non-governmental organisation ▫ European Commission ▫ Regulator ▫ Public funder ▫ National government ▫ Local government ▫ Other
3a	If you selected Other, please specify: [Textbox]
3b	Organisation name [Textbox]
3c	Your role within the organisation (e.g. CEO, Project manager, Technical staff, Researcher, Student, …) [Textbox]
3d	Country you are based in [Textbox]
	Page 2: General DTOceanPlus
4	How familiar were you with the original DTOcean Tool? ▫ I had never heard of it before ▫ I knew about it, but I have never used it ▫ I have used ▫ I have used several times or more
4a	Were/are you involved in the projects developing DTOcean/DTOceanPlus? ▫ DTOcean ▫ DTOceanPlus
	PROJECT LIFECYCLE
5	How likely are you to use DTOceanPlus for each of the three stages? - Concept definition, - Feasibility, - Design. Rank as: Not very likely / Likely / Very likely

№	Question
6	At each of the three stages, which is of more importance: speed of computation or detail (accuracy and complexity) of the results? - Concept definition, - Feasibility, - Design. Rank as: Speed is much more important / Speed is slightly more important / Balance between speed & detail / Detail is slightly more important / Detail is much more important
7	Related to the level of detail needed in the input information to DTOceanPlus, how long would you expect to spend in data formatting and inputting for each of the three stages? *(You can select multiple options if the time range you expect is not specified)* - Concept definition, - Feasibility, - Design. Select from: 1 hour / 1 day / 3 days / 1 week / 2 weeks / 1 month
8	Thinking about the level of training and experience required to do the data processing and software such as DTOceanPlus. At each of the three stages, are you more likely to get another member of your team or a consultant to assist you, or would you complete training to use the software yourself? - Concept definition, - Feasibility, - Design. Select from: Get someone else to run it / Equally likely / Learn to use the software
9	If you will be using the DTOceanPlus tools yourself, how important are the following characteristics? - Usability: How easy is the user can learn to operate, prepare inputs for and interpret outputs of the software. - Modularity: Degree to which the software is composed of discrete components that can work independently. - Flexibility & expandability: How easy is to adapt, expand or upgrade software capabilities to fulfil specific user needs. - Portability: Device independence, degree of which the software can be installed in another machine/operating system. Rank as: Extremely important / Very important / Somewhat important / Slightly important / Not at all important
10	Are there any other software packages that DTOceanPlus should be compatible with? (please list in order of priority) *E.g., software related to site characterisation, energy transformation and delivery, or logistics and marine operations.*
	DIGITAL REPRESENTATION
11	How important to you that the same digital representation can be used for: - Different stages in the development process - Different levels of complexity as the project develops - Different types of technology Rank as: Extremely important / Very important / Somewhat important / Slightly important / Not at all important
12	Do you have any additional input on these issues? *(Please add in any general comments or clarifications you may wish to add regarding questions on this page).* [Textbox]

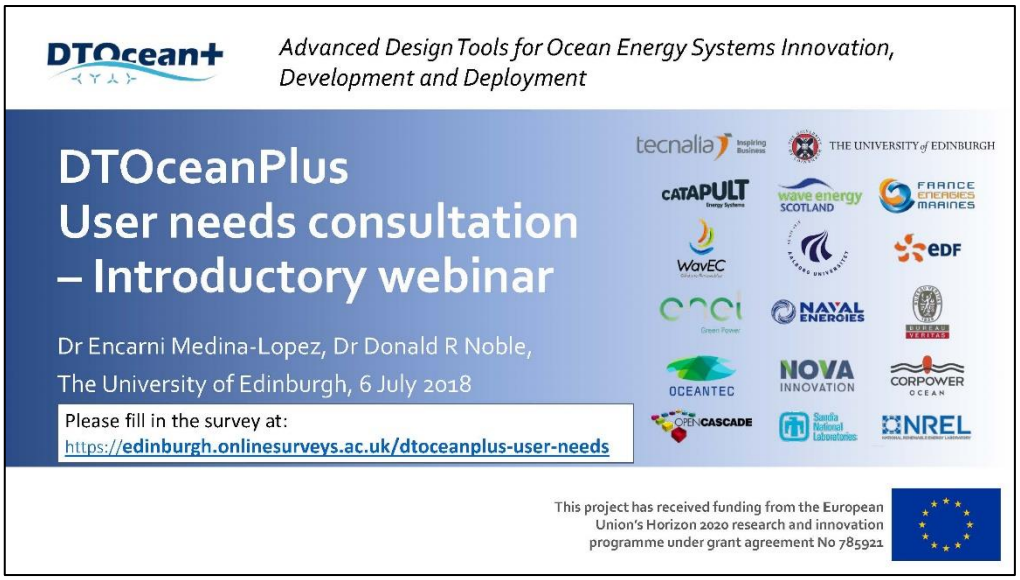
№	Question
	Page 3: Structured Innovation Tools (for concept design at all stages)
13	Do you understand (conceptually) what the Structured Innovation Tools will do? ▫ I understand what the tool will do ▫ I somewhat understand ▫ I don't really understand
14	How likely are you to use the Structured Innovation Tools within DTOceanPlus? ▫ Not very likely ▫ Likely ▫ Very likely
15	How important is it for you to innovate at the following levels (using the DTOceanPlus Structured Innovation Tools)? - Sub-system - Device - Array Rank as: Extremely important / Very important / Somewhat important / Slightly important / Not at all important
16	Which one of the following would you most expect to obtain from the Structured Innovation Tool? ▫ Answer to specific problem. Short-term solution and path to reach next level. ▫ Answer to general problem. Long-term solution and path to reach final goal.
17	How important is it that you can use DTOceanPlus to assess the following characteristics? - Identifying and quantifying challenges - Identifying enabling technologies - Generating ideas to optimise a device / array - Identifying areas of opportunity and potential investments - Designing of funding calls Rank as: Extremely important / Very important / Somewhat important / Slightly important / Not at all important
18	Is there anything specific your organisation would like to achieve from the DTOceanPlus Structured Innovation Tools? [Textbox]
19	Do you have any other comments related to the Structured Innovation Tools? *E.g. what specifically makes the Structured Innovation Tools useful/valuable, what is the most useful/valuable aspect, and what would make it more useful/valuable? Please also add in any general comments or clarifications you may wish to add regarding questions on this page.* [Textbox]
	Page 4: Stage-Gate Tools (Metrics to measure technology development)
20	Do you understand (conceptually) what the Stage Gate Tools will do? ▫ I understand what the tool will do ▫ I somewhat understand ▫ I don't really understand
21	How likely are you to use the Stage Gate Design Tool within DTOceanPlus? ▫ Not very likely ▫ Likely ▫ Very likely

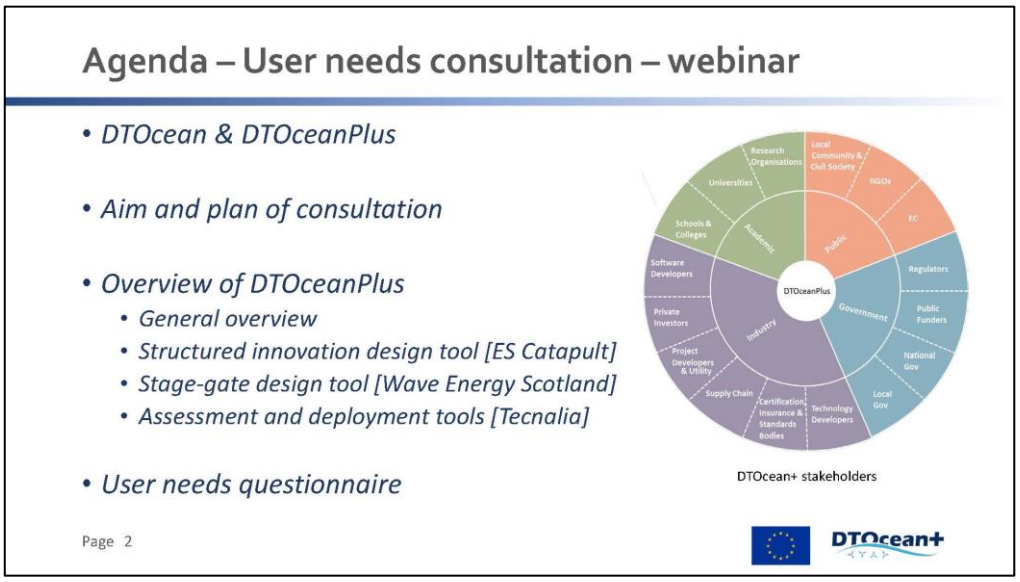
№	Question
22	How important is it for you to assess development stage at the following levels (using the DTOceanPlus Stage Gate Tools) - Sub-system - Device - Array Rank as: Extremely important / Very important / Somewhat important / Slightly important / Not at all important
23	How important is it for you to assess development stage for the following aspects (using the DTOceanPlus Stage Gate Tools) - Reliability - Availability - Maintainability - Survivability - Performance - Lifetime Cost - Energy Yield - Environmental - Social Rank as: Extremely important / Very important / Somewhat important / Slightly important / Not at all important
24	How important is it for you to assess development stage for the following aspects (using the DTOceanPlus Stage Gate Tools) - Comparison with standard benchmarks - Assessing the stage a device/technology is at - Assessing areas of compliance and non-compliance - Identifying steps to reach next stage - Providing evidence for investors/market Rank as: Extremely important / Very important / Somewhat important / Slightly important / Not at all important
25	Is there anything specific your organisation would like to achieve from the DTOceanPlus Stage-Gate Tools? [Textbox]
26	Do you have any other comments related to the Stage-Gate Tools? *E.g. what specifically makes the Stage-Gate Tools useful/valuable, what is the most useful/valuable aspect, and what would make it more useful/valuable? Please also add in any general comments or clarifications you may wish to add regarding questions on this page.* [Textbox]
	Page 5: Deployment and Assessment Tools (Supporting optimal device and array deployment)
27	Do you understand (conceptually) what the Deployment and Assessment Tools will do? ▫ I understand what the tool will do ▫ I somewhat understand ▫ I don't really understand
28	How likely are you to use the Deployment and Assessment Tools within DTOceanPlus? ▫ Not very likely ▫ Likely ▫ Very likely

№	Question
29	How important is it for you to use the Deployment and Assessment Tools at the following levels? - Sub-system - Device - Array Rank as: Extremely important / Very important / Somewhat important / Slightly important / Not at all important
30	How important is it for you that the Deployment and Assessment Tools allow you to: - Compare different devices in the same location - Compare different locations with the same device - Assess a combined array of multiple device/technology types at one location (e.g. devices with different power ratings, or multiple different generation technologies) Rank as: Extremely important / Very important / Somewhat important / Slightly important / Not at all important
31	How important is it for you that you can use DTOceanPlus to assess the following aspects of a project? - Site characterisation (e.g. metocean, geotechnical and environmental conditions) - Energy capture (e.g. array layout) - Energy transformation (e.g. power take-off) - Energy delivery (e.g. cabling layout) - Station keeping (e.g. foundations and moorings) - Logistics, Operations and Maintenance) Rank as: Extremely important / Very important / Somewhat important / Slightly important / Not at all important
32	How important is it for you that you can use DTOceanPlus to assess the following characteristics? - Optimising balance of plant - Identifying areas for cost reduction - Maximising energy delivery) - Quantifying social and environmental benefits - Assessing optimal location for a given device - Assessing optimal device for a given location - Planning deployment and operations Rank as: Extremely important / Very important / Somewhat important / Slightly important / Not at all important
33	Is there anything specific your organisation would like to achieve from the DTOceanPlus Deployment and Assessment Tools? [Textbox]
34	Do you have any other comments related to the Deployment and Assessment Tools? *E.g. what specifically makes the Deployment and Assessment Tools useful/valuable, what is the most useful/valuable aspect, and what would make it more useful/valuable? Please also add in any general comments or clarifications you may wish to add regarding questions on this page.* [Textbox]

№	Question
	Page 6: Final Comments
35	What do you expect the most useful/valuable part of DTOceanPlus for you or your organisation and why? [Textbox]
36	If you have any other comments regarding DTOceanPlus, or there is anything you would like to add to this questionnaire, you can do so here. [Textbox]

ANNEX II: INTRODUCTORY WEBINAR SLIDES



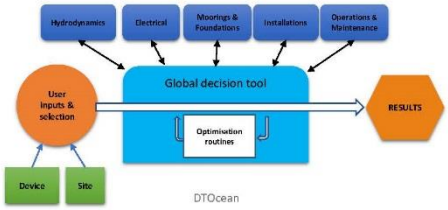


DTOcean & DTOceanPlus

- **DTOcean**: EU funded 2013 - 2016

  7th Framework Programme for R&D
  ENERGY 2013-1

- Accelerate development of ocean energy – design tools for ocean energy 1st generation deployment.

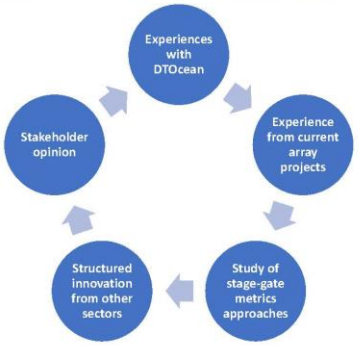


DTOceanPlus: EU funded 2018 – 2021
H2020 Programme, LCE-16-2017
"Advanced Design Tools for Ocean Energy Systems Innovation, Development and Deployment"

Page 3

User needs consultation – aims and plans

- Refinement of user needs
  - Collect inputs from different stakeholders in a multi-level approach
  - Produce user requirements in terms of metrics, functionalities, and demonstration case studies.
- User consultation
  - Webinar to explain project and proposed tools
  - Questionnaire to gauge user needs
  - Follow up interviews with key stakeholders

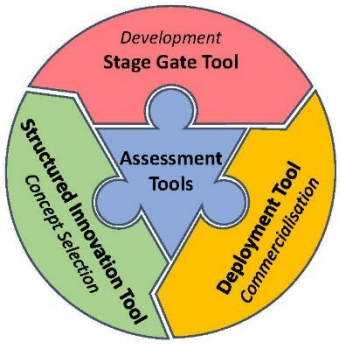


Page 4

DTOceanPlus Objectives

- To develop and demonstrate an open source, integrated suite of 2nd generation design tools
- For ocean energy technologies including sub-systems, energy capture devices, and arrays
- That support the entire technology innovation process (i.e. from concept, through development, to deployment)
- Relevant and of great value to a wider group of key stakeholders

Underlying Digital models:
- A standard framework for the description of sub-systems, devices and arrays
- Communication method for the various tools
- Common language for the entire sector

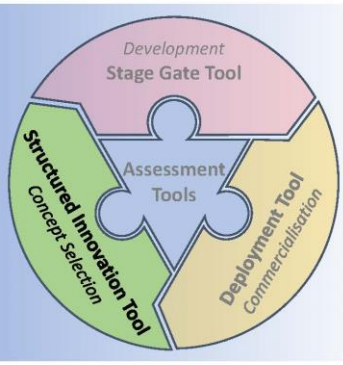


Page 5

User needs consultation – Internal webinar

Overview of Structured Innovation Tool

Nick Eraut,
Energy Systems Catapult



Page 6

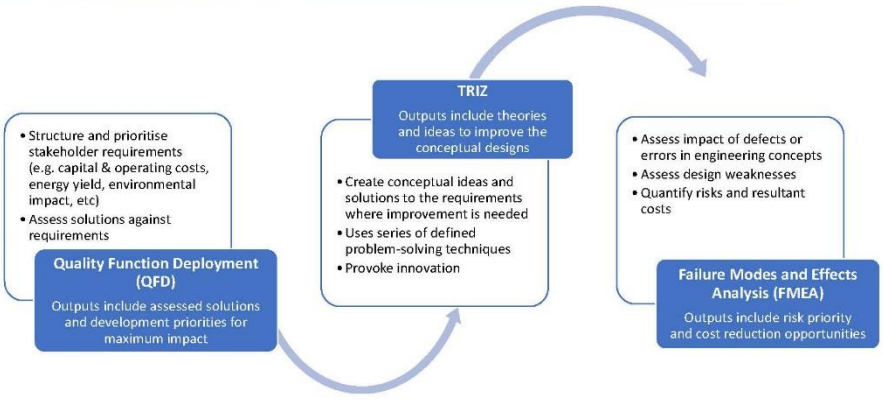
Structured Innovation

Aims:

- Capture the "Voice of the Stakeholder"
- Provide an innovation toolkit, with validated input data and methods
- Link to Stage Gate Design Tools with innovative solutions, priorities, and risks

Page 7

Structured Innovation – Three Tools



Page 8

Structured Innovation

Puts rigour and innovation at the heart of concept creation, using QFD, TRIZ and FMEA

- Captures and prioritises requirements
  - What does the customer really want?
- Assesses solutions for impact
  - How can we meet those needs?
- Provides problem solving for contradictions
  - I want power, but low cost
- Encourages risk assessment and mitigation
  - How can I overcome my design reliability without adding cost?

Gives development direction and impact

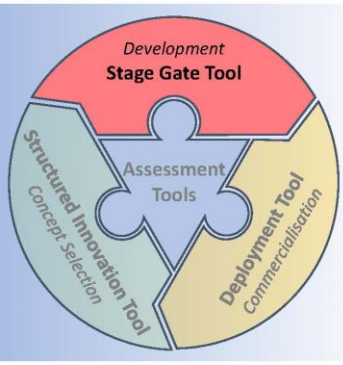
- Improve the impact per unit development cost
- Improve commercial acceptability

Page 9

User needs consultation – Internal webinar

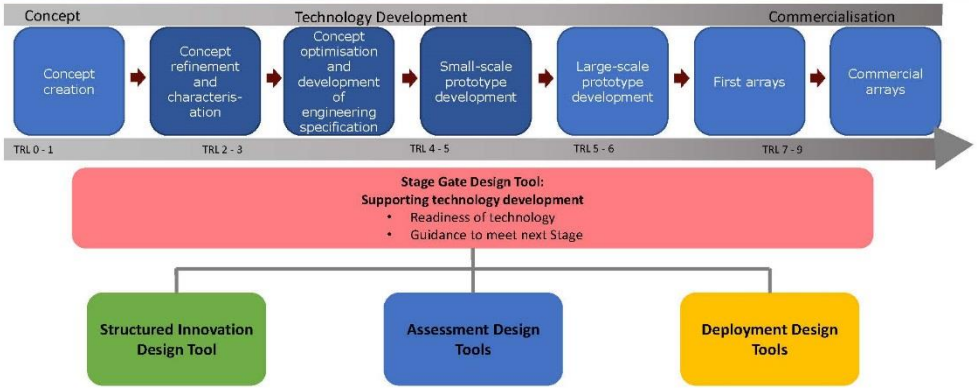
Overview of Stage Gate Tool

Jillian Henderson,
Wave Energy Scotland



Page 10

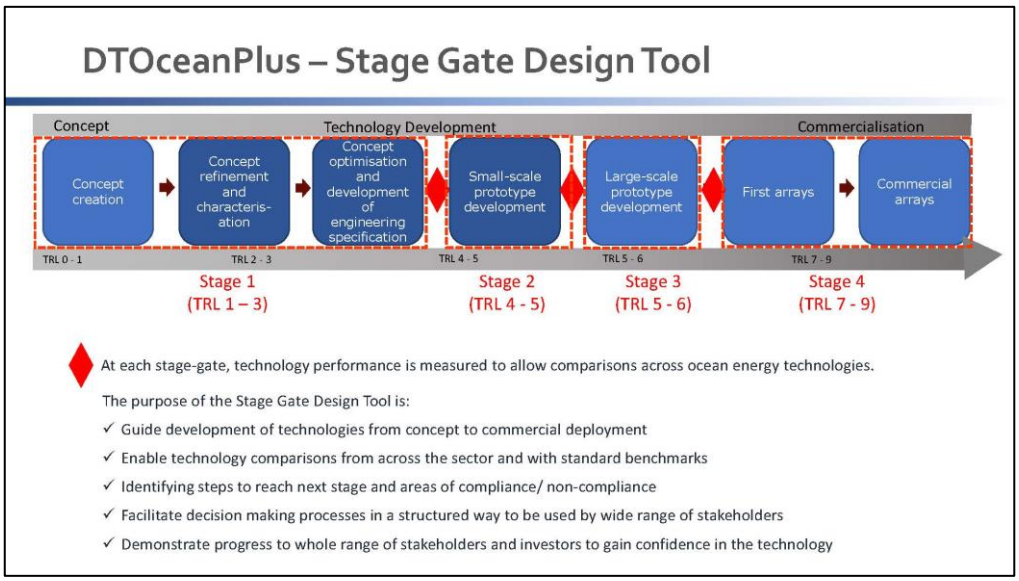
DTOceanPlus – Overview of Tools

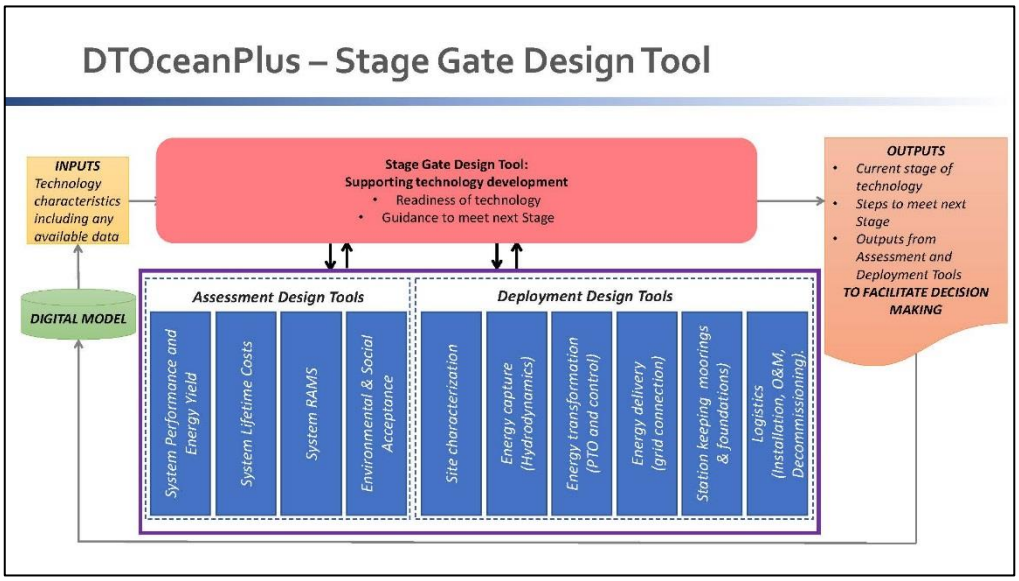


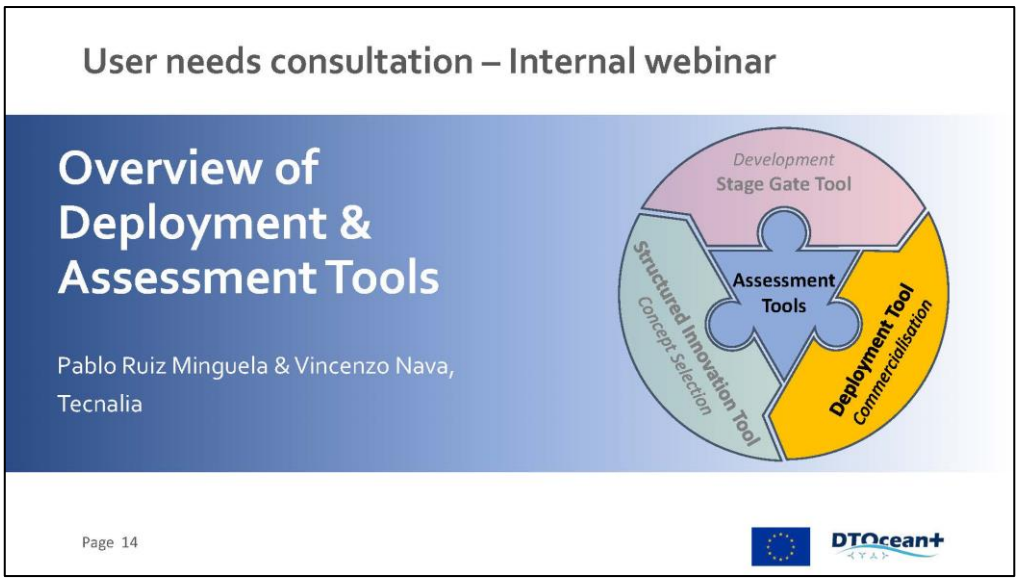
Page 11

Provides the framework within which:

- Concepts produced from the Structured Innovation Tool can be assessed
- Deployment Design Tools and Assessment Design Tools can be applied


DTOceanPlus – Stage Gate Design Tool
Concept
Technology Development
Commercialisation
Concept creation
Concept refinement and characteris-ation
Concept optimisation and development of engineering specification
Small-scale prototype development
Large-scale prototype development
First arrays
Commercial arrays
TRL 0 - 1
TRL 2 - 3
TRL 4 - 5
TRL 5 - 6
TRL 7 - 9
Stage 1 (TRL 1 – 3)
Stage 2 (TRL 4 - 5)
Stage 3 (TRL 5 - 6)
Stage 4 (TRL 7 - 9)
At each stage-gate, technology performance is measured to allow comparisons across ocean energy technologies.
The purpose of the Stage Gate Design Tool is:
✓ Guide development of technologies from concept to commercial deployment
✓ Enable technology comparisons from across the sector and with standard benchmarks
✓ Identifying steps to reach next stage and areas of compliance/ non-compliance
✓ Facilitate decision making processes in a structured way to be used by wide range of stakeholders
✓ Demonstrate progress to whole range of stakeholders and investors to gain confidence in the technology


DTOceanPlus – Stage Gate Design Tool
INPUTS
Technology characteristics including any available data
Stage Gate Design Tool:
Supporting technology development
• Readiness of technology
• Guidance to meet next Stage
OUTPUTS
• Current stage of technology
• Steps to meet next Stage
• Outputs from Assessment and Deployment Tools
TO FACILITATE DECISION MAKING
DIGITAL MODEL
Assessment Design Tools
System Performance and Energy Yield
System Lifetime Costs
System RAMS
Environmental & Social Acceptance
Deployment Design Tools
Site characterization
Energy capture (Hydrodynamics)
Energy transformation (PTO and control)
Energy delivery (grid connection)
Station keeping moorings & foundations)
Logistics (Installation, O&M, Decommissioning)


User needs consultation – Internal webinar
Overview of Deployment & Assessment Tools
Pablo Ruiz Minguela & Vincenzo Nava, Tecnalia
Development
Stage Gate Tool
Assessment Tools
Structured Innovation Tool
Concept Selection
Deployment Tool
Commercialisation
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DTOcean+

DTOceanPlus - Deployment & Assessment Design Tools

- New toolset built upon the **DTOcean platform**. Improvements in terms of:
  - ✓*Design accuracy*
  - ✓*Management of uncertainties*
  - ✓*Usability*
  - ✓*Running time*
- Use of a **standard digital representation of ocean energy systems.**
- Use of a **standard core platform** (Salome).
- Ability to manage **different levels of** granularity/coarseness of input **data.**
- **Interface** with already available **commercial options**.

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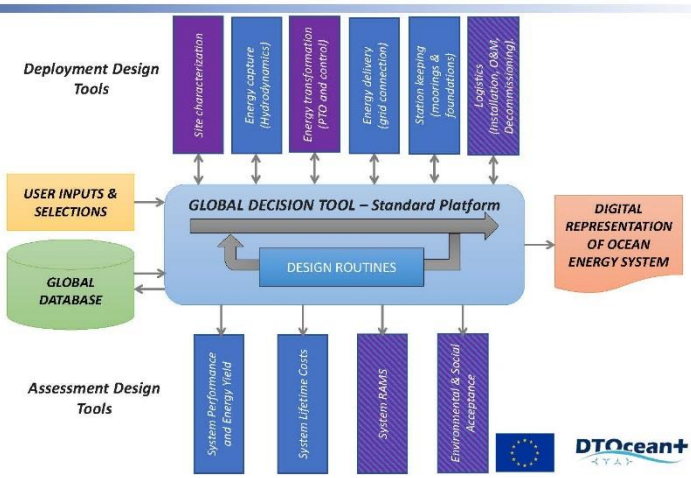
DTOceanPlus - Deployment & Assessment Design Tools

- **Scope to be widened** with new modules (**purple**) and improved functionality on the 1st gen. tools (**blue**)
- Provide **optimal system designs** (devices & arrays)



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User needs consultation – Internal webinar

User needs questionnaire

Dr Donald R Noble,
The University of Edinburgh

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User needs questionnaire – General

- 35 questions over 5 pages:
  - Your Details;
  - General DTOceanPlus;
  - Structured Innovation;
  - Stage Gate;
  - Deployment & Assessment

- Project engagement – *optional contact details*
  - Hold details for the project duration to keep you informed
  - Participation in optional follow up interviews

- *About 15 minutes to complete*
- *Multiple choice, rankings, and free text input*
- *Please add in comments if you want to further explain your choices*

- Organisation details – *type, name, role, country*
  - You can respond anonymously, but details help us understand our users
  - Responses will be aggregated and not individually attributable

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User needs – General – Project lifecycle

- Project lifecycle – DTOceanPlus used at multiple stages:
  - **Concept definition:** (TRL 1-3) early stage analysis of potential device or site. Gives an overview of capabilities and next development steps, but may be based on limited data.
  - **Feasibility:** (TRL4-6) includes an in-depth study of the topics covered in the concept definition. More accurate than previous stage, with additional data requirements.
  - **Design:** (TRL 7-9) key project features are planned in this stage, informed by the previous phases. Makes use of detailed information about the project.

- At each stage:
  - Likelihood of use?
  - Balance between speed of computation or the detail (accuracy and complexity) of results?
  - Duration expected for data formatting and inputting?
  - Training to use software, or get a colleague/consultant to use?

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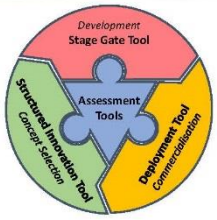
User needs – Questions on the tools

- For each of the tools:
  - Structured Innovation; • Stage Gate; • Deployment & Assessment



- How well you understand (conceptually) what the tool will do
- How likely are you to use these tools, and importance for:
  - Sub-system • Device • Array
- Tool specific questions... (next slides)
- Free text boxes to add specific requirements and other comments on each tool.

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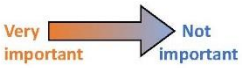
User needs – Structured innovation (SI) tool

- SI for specific/general problems:
  - Specific problem. Short-term solution and path to reach next level.
  - General problem. Long-term solution and path to reach final goal.

- Importance of using SI within DTOceanPlus for:
  - Identifying and quantifying challenges
  - Identifying enabling technologies
  - Generating ideas to optimise a device/array
  - Identifying areas of opportunity
  - Designing of funding calls



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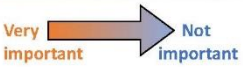
User needs – Stage gate tool

- Importance that you can use Stage Gates to:



1. Assess development stage of different aspects
   - Reliability
   - Availability
   - Maintainability
   - Survivability
   - Performance
   - Lifetime Cost
   - Energy Yield
   - Environmental
   - Social aspects

2. Assess various characteristics
   - Comparison with standard benchmarks
   - Assessing the stage a device/technology is at
   - Assessing areas of compliance and non-compliance
   - Identifying steps to reach next stage
   - Providing evidence for investors/market

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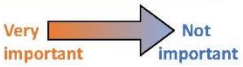
User needs – Deployment & assessment tools

- Importance of using DTOceanPlus tools for:



  1. Comparing devices and locations
  2. Assess & optimise different aspects & characteristics of a project:

- Site characterisation (e.g. metocean, geotechnical and environmental conditions)
- Energy capture (e.g. array layout)
- Energy transformation (e.g. power take-off)
- Energy delivery (e.g. cabling layout)
- Station keeping (e.g. foundations and moorings)
- Logistics, Operations and Maintenance
- Optimising balance of plant
- Identifying areas for cost reduction
- Maximising energy delivery
- Quantifying social and environmental benefits
- Assessing optimal location for a given device
- Assessing optimal device for a given location
- Planning deployment and operations

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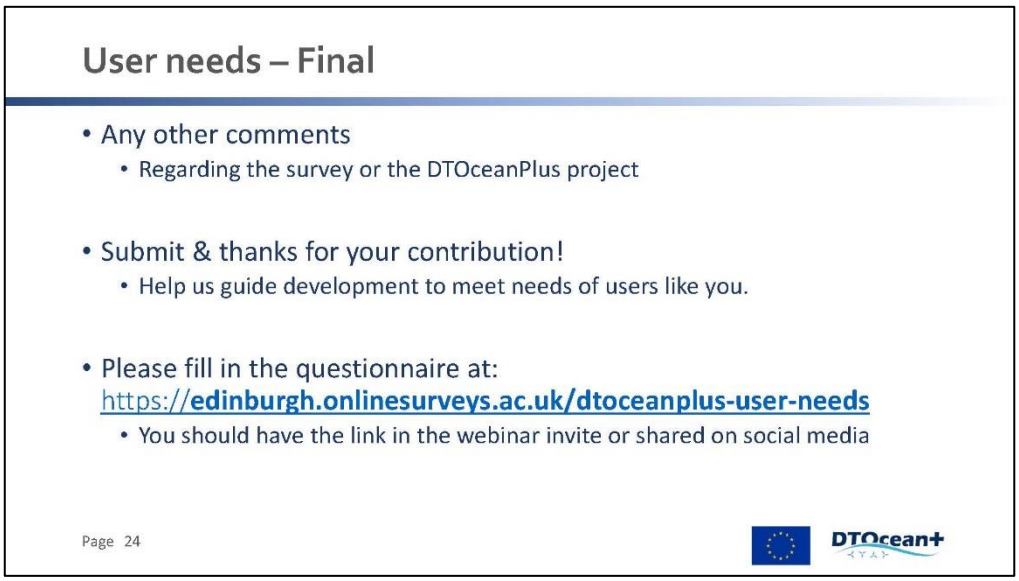
User needs – Final
• Any other comments
• Regarding the survey or the DTOceanPlus project
• Submit & thanks for your contribution!
• Help us guide development to meet needs of users like you.
• Please fill in the questionnaire at:
https://edinburgh.onlinesurveys.ac.uk/dtoceanplus-user-needs
• You should have the link in the webinar invite or shared on social media
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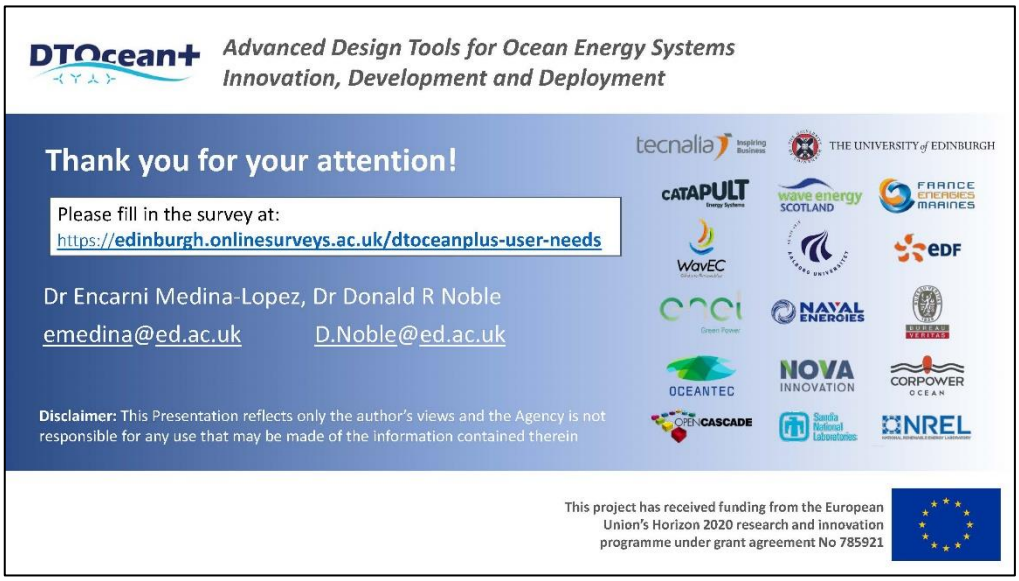
DTOcean+


DTOcean+
Advanced Design Tools for Ocean Energy Systems
Innovation, Development and Deployment
Thank you for your attention!
Please fill in the survey at:
https://edinburgh.onlinesurveys.ac.uk/dtoceanplus-user-needs
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NAVAL ENERGIES
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CORPOWER OCEAN
OPEN CASCADE
NREL
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 785921

ANNEX III: FACTSHEET ON DTOCEAN AND DTOCEANPLUS

DTOceanPlus CONSULTATION – INFORMATION DOCUMENT

This document summarises information related to the first generation DTOcean tool and the DTOceanPlus project, in order to provide background to answer the questions provided in the consultation developed to understand user requirements for the latter.

DTOcean – First generation

DTOcean was a European collaborative project funded by the European Commission under the *7th Framework Programme for Research and Development*, more specifically under the call ENERGY 2013-1. The project ran from 2013 to 2016. DTOcean stands for Optimal Design Tools for Ocean Energy Arrays, aimed at accelerating the industrial development of ocean energy power generation knowledge by providing design tools for deploying the first generation of wave and tidal energy converter arrays.

The areas of hydrodynamic array layout, electrical infrastructure, operations, maintenance, moorings & foundations, and installation & logistics bring critical challenges which must be addressed for the ocean energy sector in order to reach commercialisation. The DTOcean project brought together an integrated suite of tools, shown in Figure 1, to address the challenges present to progress ocean energy, as the sector progresses from single devices to arrays. The tools form core elements of progression beyond current state-of-the-art knowledge. DTOcean has a significant focus on the economic, environmental and reliability challenges. This ensured that each step of the design process considered the overall impact of individual tool decisions, ensuring environmentally appropriate project development. The result culminated in a suite of open source design tools for the ocean energy sector. DTOcean is free to access and download (https://github.com/DTOcean).

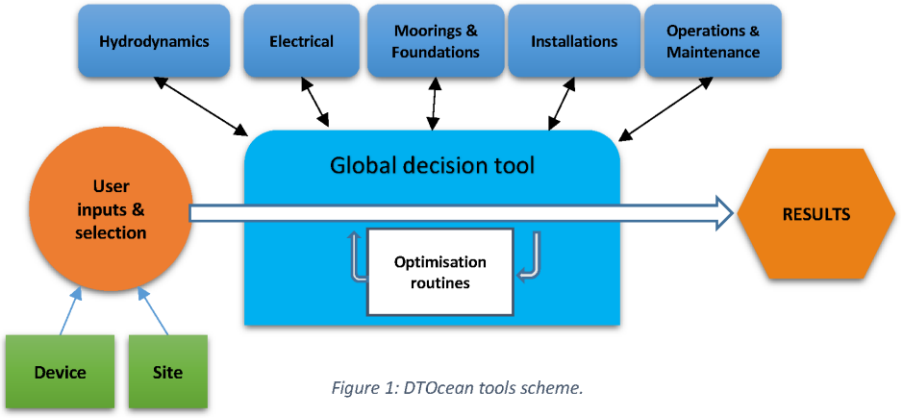

Figure 1: DTOcean tools scheme.

DTOceanPlus – Second generation

The DTOceanPlus concept is brought because of the need to extend and complete the first generation of tools (DTOcean). DTOceanPlus is another European collaborative project funded by the European Commission under the Horizon2020 Framework Programme, specifically under the call LCE-2016-2017. The project started in May 2018, and will run for 3 years.

DTOceanPlus will accelerate the development of the Ocean Energy sector by developing and demonstrating a second generation of advanced design tools for the selection, development and deployment of ocean energy systems, shown in Figure 2. Moreover, innovation and development processes will be aligned with those used in mature engineering sectors, such as:

- **Technology concept selection**. This will be facilitated by *Structured Innovation* Tools.
- **Technology development**. This will be enabled by *Stage-Gate* Tools.
- **Deployment optimisation**. This will be implemented by *Deployment and Assessment* Tools.

This suite of design tools will reduce the technical and financial risks of devices and arrays to achieve the deployment of cost-competitive wave and tidal arrays. This will be focused on the reduction of the Cost of Energy. DTOceanPlus will achieve this by facilitating improvement of the reliability, performance and survivability of ocean energy systems and analysing the impact of design on energy yield, operations and maintenance, and the environment, making the sector more attractive for private investment.

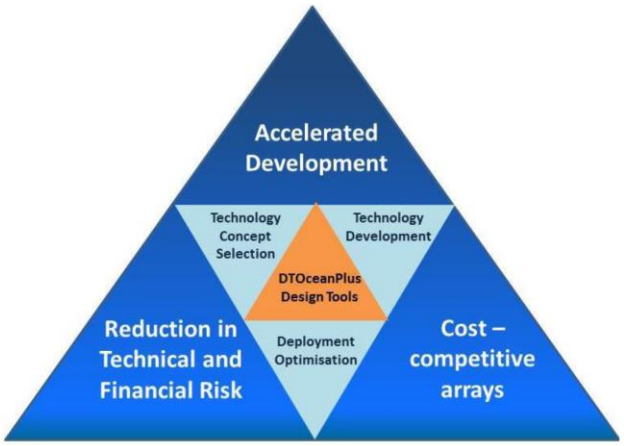

Figure 2: DTOceanPlus mission.

The DTOceanPlus suite of tools will be a professional user-friendly product and made freely available as open-source to the entire ocean energy sector. This will ensure maximum impact and usability of the tools. By producing standardise data models of ocean energy systems and by interfacing with industry standard software packages the result will be streamlined. Open access will allow these tools to be used for education, training and knowledge exchange.

With applicability at regional, national, European, and international levels, the DTOceanPlus suite of tools will be designed for technology developers, project developers, public funding bodies, and private investors. The results provided by this suite of tools will also be relevant and of great value to a wider group of key stakeholders including policy makers, regulators, standard bodies, insurance providers and supply chain. This will contribute to the strengthening of the European industrial technology base, increasing job growth and competitiveness.

The suite of tools is illustrated in Figure 3. Technology concept selection will be enabled by the Structured Innovation design tool, technology development will be supported by the Stage-gate design tool, while technology deployment will be guided by the Deployment design tools. These tools will be combined with Assessment Design tools to measure improvement to reliability, performance, and survivability of ocean energy systems as well as analysing the impact of design on energy yield, O&M costs, and the environment. The strength of the suite of DTOceanPlus tools is the capability offered by having an integrated set of tools which function on devices as well as arrays which for example allows a technology developer to test easily how their technology may be deployed in a farm and thereby enabling early identification of best solutions to ensure lowest long-term cost of energy.

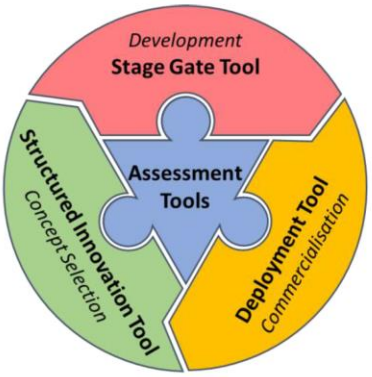

Figure 3: DTOceanPlus concept.

Central to the integration of these sets of tools will be a set of digital models for ocean energy systems. These models will provide a standard framework for the description of sub-systems, devices and arrays. Not only will these models provide the communication method between the various tools in the DTOceanPlus suite, they will also provide a common language for the entire ocean energy sector. This common language will significantly enhance the ability of sector stakeholders to work collaboratively, thus accelerating development of the sector, whilst also further supporting stakeholders who wish to make objective comparisons between various technologies.

ANNEX IV: DTOCEANPLUS INFORMED CONSENT FORM

DTOceanPlus Informed Consent Form

You have been asked to complete a questionnaire in support of the DTOceanPlus project of the Horizon 2020 program of the European Commission. This letter of informed consent describes the project and the terms of your cooperation.

About the project

The general objective of DTOceanPlus will develop and demonstrate an open source, integrated suite of 2nd generation design tools for ocean energy technologies that support the entire technology innovation process. This suite of design tools will accelerate the development of the Ocean Energy sector and reduce the technical and financial risks of devices and arrays to achieve the deployment of cost-competitive wave and tidal arrays.

The DTOceanPlus project will create a network of stakeholders with different profiles to have a comprehensive and up-to-date understanding of the needs for design tools from different points of view.

The final aim is to ensure that the tools produced by DTOceanPlus will cover real industrial needs towards the development and deployment of cost-effective ocean energy devices and arrays.

The DTOceanPlus project is funded by the European Commission under Horizon 2020, running from 01 May 2018 to 30 April 2021, with an overall budget of approximately € 8 million. The project gathers partners from 6 European countries that cover the Ocean Energy value chain.

Detailed information about data protection

- Data Controller: The DTOceanPlus Consortium (Full details of project partners can be found on the website).

- Purpose of data collection: The aim of collecting information is to learn more about the industrial needs towards the development and deployment of cost-effective ocean energy devices and arrays. No sensitive personal data will be collected. Personal data will be collected and stored only in so far as this is necessary to identify an expert or stakeholder in his or her official or professional role (e.g. Name, Country of residence, Represented institution, Role in this institution, Phone number, Email address). This is the information which is usually provided on the experts or stakeholders business cards and which is usually accessible in the public space or on their institutions' websites.

- Data storage: Your answers will be completely anonymous. Your answers will be separated from any information from which your identity may be determined. You will be given the opportunity to review the results of this questionnaire, and have the option to amend your input. After completion of the study, the data will be securely removed.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 785921

- Refusal or cessation of participation: Participation in this study is voluntary. You do not have to participate in the study if you do not want to. If you choose to participate, you can nonetheless choose to withdraw or leave the study at any time without consequences for you, and without being required to provide any explanations. This refusal will not invalidate any lawful action previously done when we had your express authorisation.

- Permission to process your data: Your consent means that you authorise us to process this personal data. However, you may exercise at any time your right to access, correct, or erase personal data, and others described below.

- **Data transfer to third parties:** Your data will not be transferred to third party companies unless legally obliged to do so. DTOceanPlus can use services from companies outside Europe to process the data (e.g. contact information management, sending messages, etc.) such as such as Microsoft Corporation, with whom we work in accordance with the express authorisation from the National Data Protection Agency. Please note that if you share your information with us through social networks such LinkedIn we cannot accept any responsibility on their privacy policy. You are encouraged to review their policy at https://www.linkedin.com/legal/privacy-policy?trk=uno-reg-guest-home-privacy-policy before sharing any information.

Rights

You have the right to know whether we are processing your personal data or not.

You have the right to access your personal data, which implies knowing which elements of your data are being used, the purpose and the period of use, among other information. This also includes the right to request the rectification of data that are inaccurate or incomplete and even to request that the data be deleted when they are no longer necessary for the purpose for which they were collected.

If your personal data were made public and the data controller is obliged to delete them, you can request that the data controller adopt measures to notify all persons authorised to process the data of your intention to delete the said data (the right to be forgotten).

In some cases, the interested person may request that processing is restricted. In this case, the data may be stored to exercise their defence or to make claims. If the limitation of processing is withdrawn, the interested person should be informed of this.

In some situations, you may oppose the processing of your data. In these cases, we shall stop processing your data, provided that there are no other compelling legitimate grounds or if these data will be used to exercise or defend possible claims.

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You have the right to receive the data provided to the data controller to whom they correspond or to have these data transferred to another data controller.

The interested persons have the right to file a claim before the control authority.

If you have any questions or comments regarding this study – now or at a later date – please do not hesitate to get in touch with the coordinator of the project, or representatives of the DTOceanPlus consortium conducting this interview.

We hereby ask that you give us your express consent, indicated by completing question 1, accepting the processing of your data in accordance with the new regulation.

CONTACT DETAILS

Mr. Pablo Ruiz-Minguela

Project Coordinator, TECNALIA

www.dtoceanplus.eu

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