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

Deliverable D2.3

Demonstration Methodology

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EXECUTIVE SUMMARY

DTOceanPlus will accelerate the commercialisation of the Ocean Energy sector by developing and demonstrating an open source suite of design tools for the selection, development, deployment and assessment of ocean energy systems (including sub-systems, energy capture devices and arrays). The suite of tools will include a Structured Innovation tool, for the technology concept selection; a Stage Gate tool, for the technology development process, as well as a set of Deployment Design and Assessment tools for the design of the system and its evaluation.

The suite of tools will be validated by running a valuable set of demonstration scenarios, which will show the different uses of the tools under a wide set of conditions, e.g. for various deployment sites, tidal and wave technologies, and using all the tools developed in DTOceanPlus.

This report describes the methodology used to define the "validation scenarios", accounting for the different potential use cases. Given the large number of permutations of tools, use cases, and the set of minimum validation requirements, the actual number of validation scenarios will be reduced to a number that can be run during the life of the DTOceanPlus project but that are sufficient to fully demonstrate the functionality of the DTOceanPlus suite of tools. The selection process, based on a successive approximation approach, will lead to the cases that the potential users in the DTOceanPlus consortium have considered as the most relevant for the sector.

In Section 4 of the document, the selected validation scenarios will be described; the definition of these scenarios will be completed during the project to ensure that the most updated information is used.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Dx.x	Deliverable x.x from a task or work package
PD	Project Developer
PF	Priority Factor
PSC	Project Steering Committee
TD	Technology Developer
Tx.x	Task x.x within a work package
UC	Use Case
VS	Validation Scenario
WPL	Work Package Leader

1. INTRODUCTION

1.1 SCOPE OF THE REPORT

The objective of D2.3 "Demonstration Methodology" is to document the outcome of the activities carried out within T2.3 "Demonstration Strategy" of the EU-funded DTOceanPlus project. The objective of the deliverable is to identify and describe the demonstration scenarios (in the following named also Validation Scenarios VSs) which will be run within the framework of the project to illustrate the different uses of the tools.

According to the description of T2.3 of the project, the minimum requirements of the set of selected VSs must include at least:

- **Two types** of deployment sites, one for tidal energy and another for wave energy;
- **Four technologies** (two wave and two tidal)
- **Three design tools use** – technology innovation; stage gate development and array deployment and optimisation.

After illustrating the process of identification of the VSs, a brief description of the VSs will be included and the fulfilment of the minimum requirements of the VSs will be checked. During T7.2 of the project, these validation scenarios will be updated and detailed.

Accounting for the minimum requirements of the VSs, as well as for the several use cases, the list of potential VSs could be very wide. For this reason, among the several alternatives, a selection of VCs is proposed. While the selected Validation Scenarios do not directly cover every permutation of use-case, technology type and technology aggregation level, they do deliver validation of all the tool functionalities necessary to support those permutations, meaning that the resulting validation of the suite of tools is complete.
Moreover, the choice of this selection of VSs was supported and advised by the different types of potential users of the tools present in the consortium of the DTOceanPlus project.

1.2 OUTLINE OF THE REPORT

The public deliverable D2.3 describes the methodology undertaken in order to define a set of useful validation cases VCs of the DTOceanPlus toolset, as well as including a short description of the selected VCs.

The document consists of six sections and four annexes.

- **Section 1** is an introduction to the document: the context in which this document was prepared is explained, as well as the objectives which have been achieved. A brief description of the DTOceanPlus project serves to guide the reader through the main aspects of the project.
- **Section 2** briefly describes the funnel approach used to identify the VSs. The funnel approach, consisting of three converging intermediate steps, involved various stakeholders in the definition of the VCs, allowing reduction of the number of validation cases to those which have been considered of most impact for the different typologies of users in the consortium but representative for showing all the capabilities of the tools in DTOceanPlus;

- **Section 3** describes the outcomes of the second (a brainstorming at the Project Steering Committee PSC) and third step (and internal survey) of the funnel approach. The first step was taken during the activities in T2.2, obtaining the definition of the example use cases, described in D2.2.
- **Section 4** briefly describes the selected validation cases, accounting for the results of the previous steps of the funnel approach, described in Section 3.
- **Section 5** presents the major conclusion of the work, and **Section 6** includes the main references.

The report is completed with four annexes.

- Annex A lists the example user cases, as they are reported in D2.2 of the project
- Annex B describes the process of the brainstorming at the PSC meeting;
- Annex C describes in detail the survey that the users of the tools in the DTOceanPlus consortium were asked to answer.
- Annex D collects the partners' answers to the internal survey. For confidentiality issues, only the priority matrices proposed by the partners have been included.

1.3 SUMMARY OF THE DTOCEANPLUS PROJECT

DTOceanPlus will accelerate the commercialisation of the Ocean Energy sector by developing and demonstrating an open source suite of design tools for the selection, development, deployment and assessment of ocean energy systems (including sub-systems, energy capture devices and arrays).

At a high level, the suite of tools developed in DTOceanPlus will include:

- **Structured Innovation Tools**, for concept creation, selection, and design.
- **Stage Gate Tools**, using metrics to measure, assess and guide technology development.
- **Deployment Tools**, supporting optimal device and array deployment:
  - 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 (installation, operation, maintenance, and decommissioning).
- **Assessment Tools**, to quantify key parameters:
  - System Performance and Energy Yield;
  - System Lifetime Costs;
  - System Reliability, Availability, Maintainability, Survivability (RAMS);
  - Environmental and Social Acceptance.

These will be supported by underlying common digital models and a global database, as shown graphically in Figure 1-1.

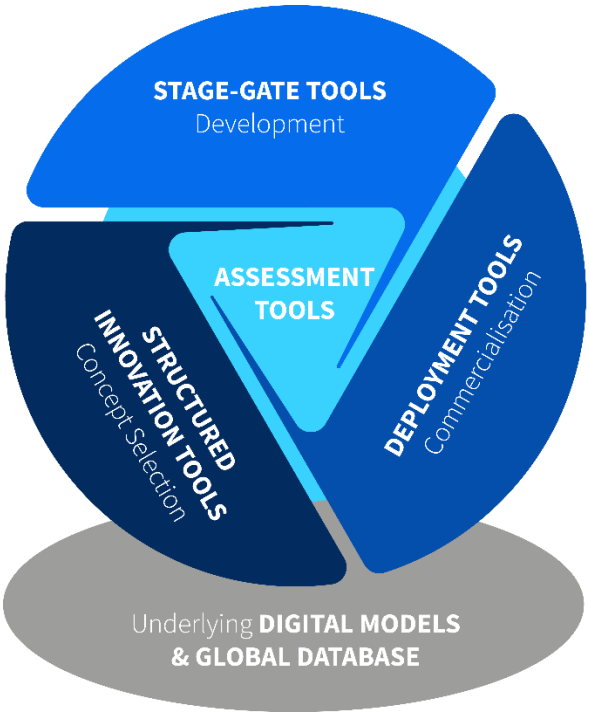

FIGURE 1-1. REPRESENTATION OF DTOCEANPLUS TOOLS

2. DEMONSTRATION METHODOLOGY

2.1 INITIAL CONSIDERATIONS

An important task within the DTOceanPlus project is to demonstrate the novel toolset using real data to validate the tools. This requires a set of VSs, also known as demonstration scenarios. The activities developed in Task 2.3 of the project are devoted to the definition of a proper methodology leading to the selection of Validation Scenarios with a certain impact and value for the sector of ocean renewable energy.

The description of T2.3 prescribes the minimum requirements to be fulfilled for the selection of the demonstration scenarios for different uses of the tools. Indeed, it is required that the toolset should be tested for at least four technologies (two for wave energy harvesting and two for tidal) in at least two deployment sites (again, one for wave and one for tidal). All the design tools should be tested: Structured Innovation design tools, Stage Gate design tools, Deployment design tools. The Assessment tools are used by all the other tools and will therefore be tested concurrently.

The toolset will cover a wide spectrum of potential users, with different needs and objectives; moreover, the toolset will be capable of work with different levels of aggregation of the system: array, device, and subsystems or components.

Considering the number of permutations of technologies, deployment sites, tools to be tested, user needs, and levels of complexity of the project, it turns out that the validation scenarios should be extracted from a very wide sample space. For this reason, a "funnel" procedure has been established to identify the most relevant Validation Scenarios.

2.2 THE FUNNEL APPROACH FOR IDENTICATION OF VALIDATION SCENARIOS

In order to identify the most relevant Validation Scenarios, a "funnel" approach has been used during the activities carried out in Task 2.3. A schematic view of the procedure is shown in Figure 2-1.

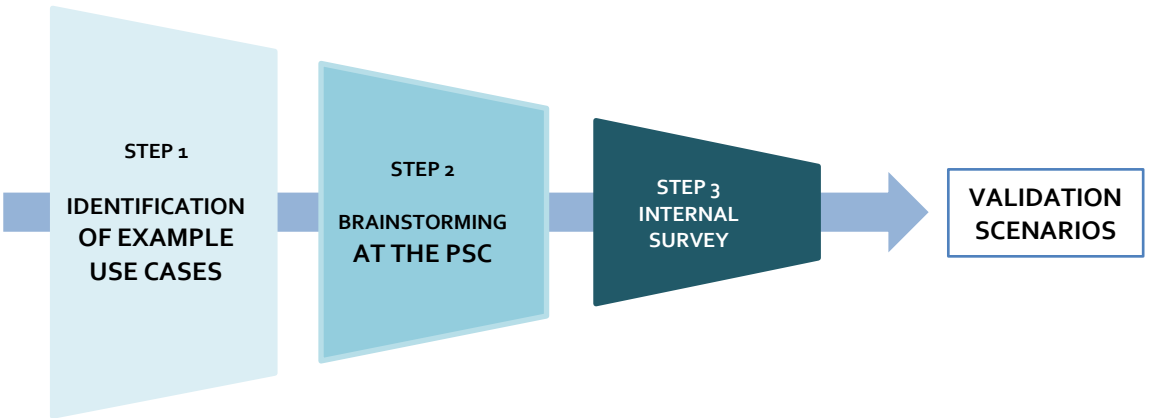

FIGURE 2-1. FUNNEL APPROACH FOR THE IDENTIFICATION OF VALIDATION SCENARIOS.

As it could be seen in Figure 2-1, the methodology is based on a three-step procedure:

1. Step 1: Identification of example Use Cases (UCs). This step is important to define the most relevant Use Cases that involve the use of the tools.
2. Step 2: Brainstorming at the Project Steering Committee (PSC). During this face-to-face meeting, a brainstorming was held to identify the most relevant areas, among the whole Example Use Case space, for validating the tools.
3. Step 3: Internal Survey. The involvement of the Technology Developers, participating in the DTOceanPlus project, served to further reduce the real needs of the sector and then select the most relevant Validation Scenario.

The funnel approach, therefore, could be seen as a gradual procedure, involving different actors and stakeholders at each stage, reducing the sample space in order to focus on the most relevant validation scenarios. The involvement of different actors at each step helped also to identify possible gaps and situations which were not identified at the previous step and that could have biased the final outcome.

2.2.1 STEP 1: DEFINITION OF EXAMPLE USE CASES

The objective of Step 1 in the funnel approach was to start reducing the sample space, by identifying the main uses for the toolset.

The definition of Example Use Cases was carried out during the definition of the Functional Requirements (Task 2.2). The procedure and the Example User cases are illustrated in the Deliverable D2.2 of the DTOceanPlus project "Functional Requirements and metrics of the second-generation design tools" [1].

The example UCs were defined per type of Tools (Structured Innovation tools, Stage Gate design tools and Deployment design tools) and per category of users (Technology Developers, Project Developers and Public and Private Investors). Other users, such as certification bodies or academics, will use the tools under one of these UCs. The Assessment design tools will also support the Structured Innovation and Stage Gate design tools.

	Structured Innovation Tools	Stage Gate Tools	Deployment Design Tools
Technology Developers	UC1.1-7	UC2.1-5	UC3.1-4
Project Developers	UC4.1-8	UC5.1-6	UC6.1-4
Private and Public Investors	UC7.1-2	UC8.1-2	UC9.1-3

FIGURE 2-2. DTOCEANPLUS MATRIX OF USERS AND USE CASES.

The matrix of the Users and Cases is reported in Figure 2-2. A total of 41 Example Use Cases were identified. The full list is reported in Annex A. However, this list is to be considered as illustrative and some other Example Use Cases could be identified.

OUTCOME: Definition of Example Use Cases.

2.2.2 STEP 2: BRAINSTORMING AT THE PROJECT STEERING COMMITTEE

The second step in the funnel approach consisted of a brainstorming activity. The objective was to further reduce the spectrum of possible combinations of potential interest for the definition of validation scenarios; and in addition, it was the first attempt to benchmark the ideas that the software developers and technical experts in the project had with respect to the software development against the Example Use Cases.

The Brainstorming activity took place in Paris on October 16th, during the PSC meeting. All the Work Package Leaders (WPLs) took part in the meeting, as well as the software developers. The list of participants to the brainstorming activity, as well as further practical details on how it was carried out, are illustrated in Annex B. The outcome of the activity and its process is illustrated in Section 3.1.

The postprocess of the outcome of the brainstorming activity served to define potential Areas of Interests, which in the following step will be contrasted against the Technology developers.

OUTCOME: Definition of Areas of Interests.

2.2.3 STEP 3: INTERNAL SURVEY

The third and final step in the funnel process involved the Technology developers that are part of the consortium of the DTOceanPlus project. Their involvement was needed in order to:

1) Check the most relevant cases on which the developers would like to run the tools, and their motivation;
2) Check the availability of data (technology, site, catalogues of components and vessels) for the defined scenarios

This step was implemented by means of a structured interview, using a spreadsheet, in which the priorities of the participants were first investigated, and then detailed. The participants to this survey were not only the Technology Developers, but also Project developers as well as other key users. Analysis of the outcome of the interview led to the definition of the validation scenarios.

The full text of the survey is in Annex C with a description of each question. The answers of the participants are collected in Annex D, while the outcome of the analysis of outcomes is reported in Section 3.2 and the proposed Validation Scenarios are reported in Chapter 4.

OUTCOME: Definition of the Validation Scenarios.

3. SCENARIO SELECTION PROCESS

3.1 BRAINSTORMING AT THE PROJECT STEERING COMMITTEE MEETING

A brainstorming activity took place during the Project Steering Committee during the Working Session about Demonstration Strategy (Paris, 16th October 2018). 18 representatives of 10 consortium partners took part in the Working Session.

The procedure, as well as the participants to the brainstorming are included in Annex B.

It is noteworthy that among all the institutions represented in the PSC meeting, there was no Ocean Energy Technology Developer. For this reason, the objective of the brainstorming activity during the PSC was not to define the validation scenarios. As an output, some areas of interest were identified by the Task Leaders and software developers, which later have been checked with the technology developers in the last step of the funnel process, i.e. through the internal survey (see Section 3.2).

3.1.1 OUTCOME OF THE BRAINSTORMING FOR TIDAL TECHNOLOGIES

Results of the poll for Tidal Technologies are reported in Figure 3-1. In this figure, the total number of votes (x axis) are reported for the type of tools to validate, and for the three levels of Aggregation (A= array, D= device, S= subsystem) in the y-axis. The colours of the bars are referred to the intended user (Public/Private Investor, Project Developer and Technology Developer).

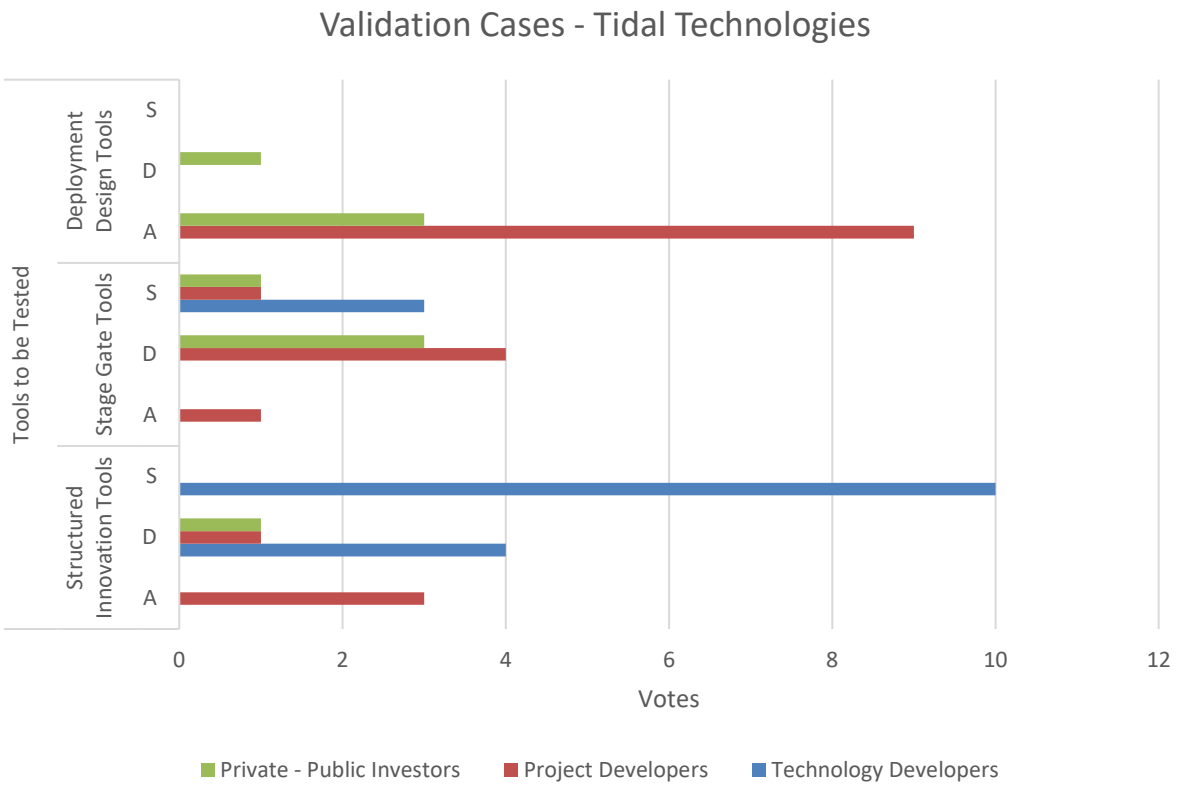

FIGURE 3-1. OUTCOME OF THE BRAINSTORMING FOR TIDAL TECHNOLOGIES.

The participants considered as most valuable a tidal scenario based on the validation of Structured Innovation tools by a Technology Developer at a level of Aggregation "Subsystem". An array farm was found as the most relevant scenario for the validation of Deployment Design Tools by Project Developers. According to the participant's judgement, the use of Deployment design tools is not considered high-importance for subsystem design. For Stage Gate Tools, there is much more spread of opinion; in this case, the validation case should involve Subsystems and/or Device.

3.1.2 OUTCOME OF THE BRAINSTORMING FOR WAVE TECHNOLOGIES

The analysis of the poll for wave technologies (see Figure 3-2) led to results partially similar to the tidal ones. Once again, the scenario of using Deployment design tools for the design of subsystems was not considered of high interest for any of the intended users of the toolset.

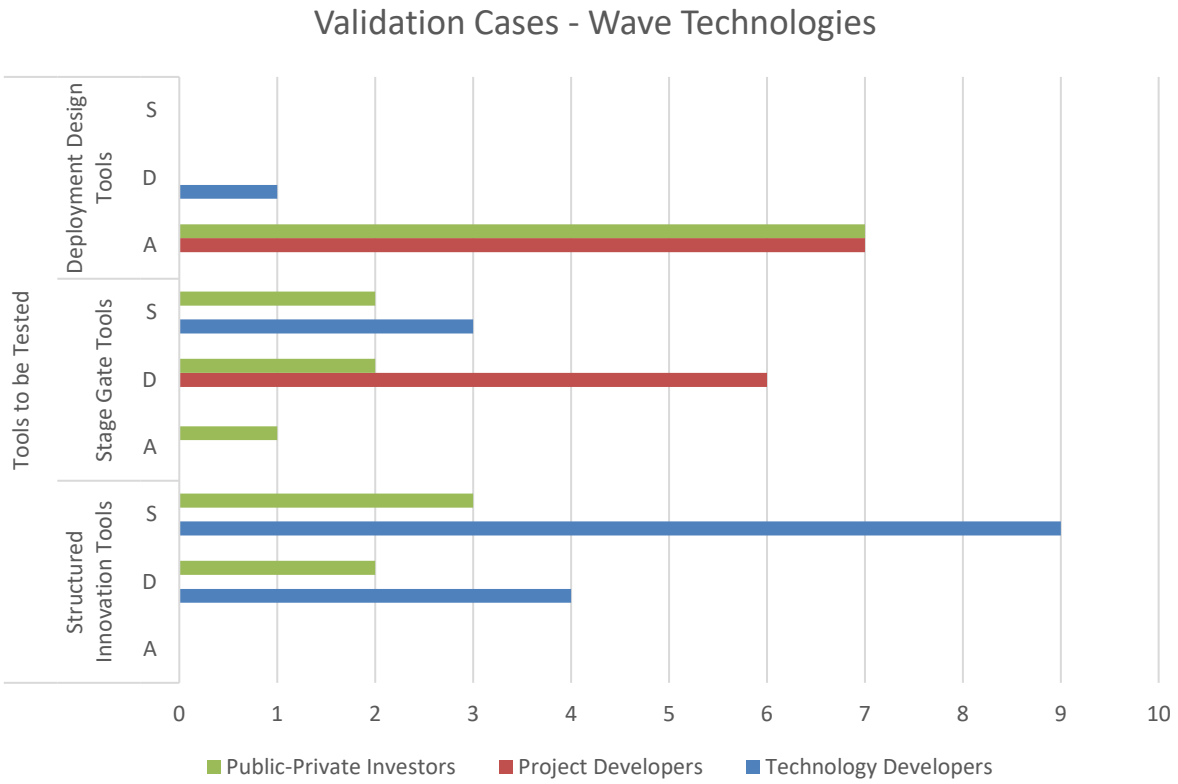

FIGURE 3-2. OUTCOME OF THE BRAINSTORMING FOR WAVE TECHNOLOGIES.

Similarly, the most voted scenario involving the use of Structured Innovation tools is at subsystem level. The validation of Deployment design tools should be performed at array level, whilst the Stage Gate tools attract the validation of scenarios at device level.

3.1.3 GLOBAL OUTCOME OF THE BRAINSTORMING

By considering the combination of the tidal and wave technology polls and considering all the votes without distinguishing per user (see Figure 3-3), the following trends have been observed:

- **Deployment design tools**: typically, the validation scenario involving its use refers to a level of aggregation of "array". This is somehow expected, as the DTOceanPlus toolset will help the design of ocean energy arrays, considering the coupling of different subsystems. At subsystem level, however, all the participants agreed that a validation of the deployment tools does not have high interest. This may arise from the fact that for assessing a specific subsystem the user would prefer the use of tailored and more specific software.
- **Stage Gate design tools**: The validation of Stage Gate tools is mainly focused on the "device" aggregation level. However, it seems that a user may also have interest in using these tools at the level of "subsystem".
- **Structured Innovation design tools**: the use of Structured Innovation tools seem to be oriented at subsystem level.

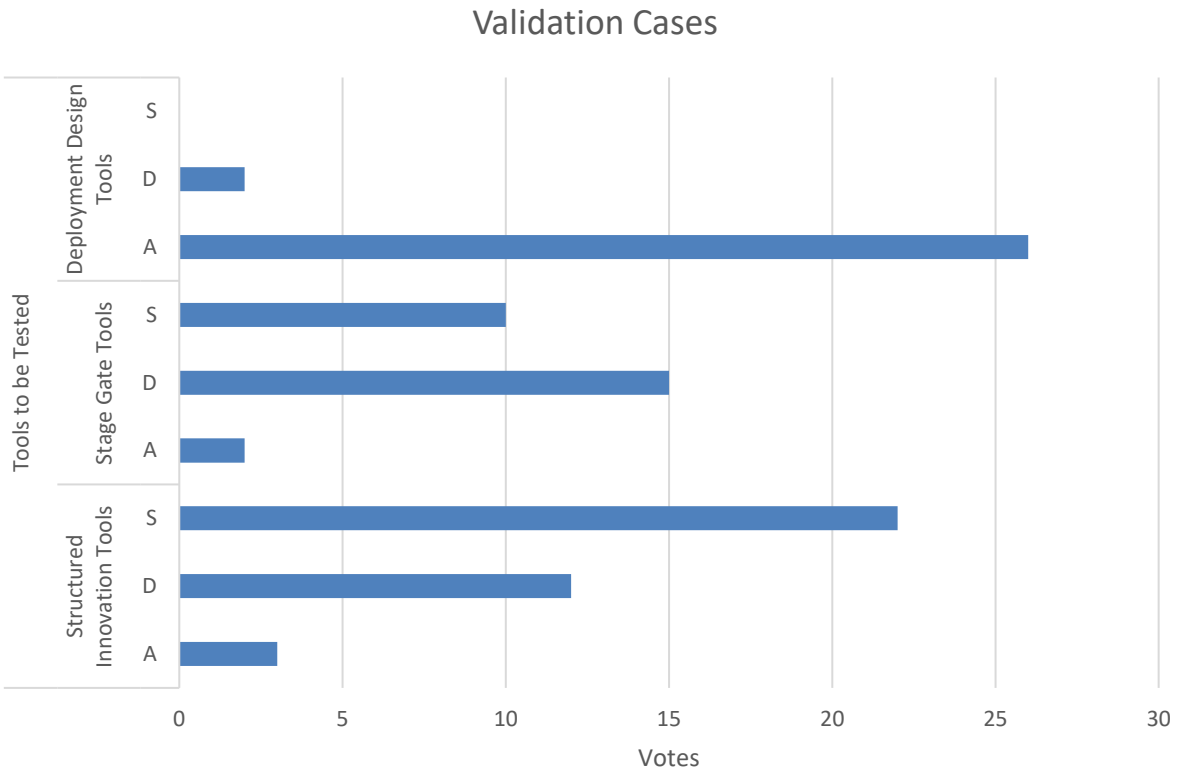

FIGURE 3-3. GLOBAL OUTCOME OF THE BRAINSTORMING FOR TIDAL AND WAVE TECHNOLOGIES.

3.1.3.1 AREA OF INTEREST AFTER THE PSC MEETING

After the PSC meeting, the information collected through the polls was postprocessed to define several demonstration scenarios. The Example Use Cases are those described in Section 2.2.1 and

Annex A2.1. It is worthwhile considering that none of the developers belonging to the consortium took part at the PSC meeting and therefore these tentative scenarios reflect just what the other members have considered as the most relevant cases for the validation of the toolset.

AREA OF INTEREST 1

Tools to be Validated	Structured Innovation design tools
Intended User	Technology Developer
Technology Types	Wave & Tidal
Aggregation Level	Device & Subsystem
Example Use Case - Objectives	UC1.1. Creating new or improving a device concept UC1.2. Creating new or improving a component for an existing device UC1.3. Identifying enabling technologies required (gap analysis) UC1.4. Generating ideas for optimising device: topology, scale(s), location(s), market(s) UC1.5. Assessing a current technology UC1.6. Identifying and quantifying challenges UC1.7. Identifying potential areas of opportunity

AREA OF INTEREST 2

Tools to be Validated	Structured Innovation design tools
Intended User	Project Developer
Technology Types	Tidal
Aggregation Level	Array & Device
Example Use Case - Objectives	UC4.1. Creating new or improving an array concept UC4.2. Identifying areas of opportunity, in terms of topology/scale(s)/ location(s)/market(s) for array/device/subsystem UC4.3. Identifying enabling technologies required (gap analysis) UC4.4. Identifying types of transition points in terms of array size/scale UC4.5. Assessing current arrays/technology UC4.6. Identifying and quantifying challenges UC4.7. Identifying areas of opportunity UC4.8. To get indications on where/how to focus use of the deployment design tools

AREA OF INTEREST 3

Tools to be Validated	Stage Gate design tools
Intended User	Project Developer
Technology Types	Wave & Tidal
Aggregation Level	Device
Example Use Case - Objectives	UC5.1. Assesses what stage their project/array is at UC5.2. Identify when to upscale (transition points) UC5.3. Identify what needs to be done to meet the next stage UC5.4. Assess when to move between different stages of development (e.g. prelim. study > feasibility > detailed design) UC5.5. Assess enabling technologies and devices (acting like an investor based on outputs from Stage Gate Metrics) UC5.6. Provide evidence for marketing/investment

AREA OF INTEREST 4

Tools to be Validated	Deployment and Assessment design tools
Intended User	Project Developer
Technology Types	Wave & Tidal
Aggregation Level	Array
Example Use Case - Objectives	UC6.1. Assess how a device/technology performs/behaves with different locations & balance of plant (either for single device or an array) UC6.2. Optimise size/scale/balance of plant in the array UC6.3. Planning deployment and O&M UC6.4. Provide evidence for marketing/investment

AREA OF INTEREST 5

Tools to be Validated	Structured Innovation design tools
Intended User	Public and Private Investors
Technology Types	Wave
Aggregation Level	Device & Subsystem
Example Use Case - Objectives	UC7.1. Identify attractive areas of innovation for investment UC7.2. (Public) Design of funding calls

AREA OF INTEREST 6

Tools to be Validated	Stage Gate design tools
Intended User	Public and Private Investors
Technology Types	Wave & Tidal
Aggregation Level	Device & Subsystem
Example Use Case - Objectives	UC8.1. Assess projects, devices, enabling technologies and (based on outputs from Stage Gate Metrics) UC8.2. (Public) Assess if device/technology ready to go to the next stage? UC8.3. (Public) Identify R&D opportunities UC8.4. (Private) Assist in investment decisions

AREA OF INTEREST 7

Tools to be Validated	Deployment and Assessment design tools
Intended User	Public and Private Investors
Technology Types	Wave & Tidal
Aggregation Level	Array
Example Use Case - Objectives	UC9.1. Assist in investment decisions UC9.2. Due diligence UC9.3. Future potential for array expansion

3.2 INTERNAL SURVEY

3.2.1 THE INVOLVEMENT OF THE CONSORTIUM PARTNERS

While performing the brainstorming exercise during the Project Steering Committee Meeting in Paris, it was pointed out that none of the technology developers in the consortium were present. For this reason, it was necessary to check if the outcome of the brainstorming was consistent or at least compatible with the needs of relevant users for the toolset.

It was, therefore, decided to carry out a survey among the participants at Task 2.3 of DTOceanPlus. The partners who took part to this exercise were:

- CorPower, as representative of a wave energy technology developer;
- IDOM (formerly Oceantec), as representative of a wave energy technology developer;
- Nova Innovation, as representative of a tidal energy technology developer;

- Orbital, as representative of a tidal energy technology developer;
- EDF, as representative of an ocean energy project developer;
- EGP, as representative of an ocean energy project developer;
- WES, as a representative of a public funding body;
- ESC, as a representative of a technology innovator;

The technology developers were not informed about the outcomes, as they did not take part to the PSC meeting, in order not to bias their answers with previous discussion.

A survey was, therefore, proposed to the partners in the consortium as part of the activities of T2.3 of the project. The detailed text of the survey is contained in Annex C.

3.2.2 ANALYSIS OF THE MOST VOTED DEMONSTRATION SCENARIOS

The individual spreadsheets as filled by the sample respondents to the survey could be found in Annex D. In this section, the outcomes are post processed, and in order to analyse and visualise the results more easily, the participants have been grouped following Table 3.1.

TABLE 3.1. GROUPING OF RESPONDENTS TO THE SURVEY.

Global Sample of Respondents	**Technology Developers**	*Wave Energy Technology Developer*	CorPower
			IDOM
		Tidal Energy Technology Developer	NOVA
			Orbital
	Project Developers		EDF
			EGP
	Other Key Users Profiles		WES
			ESC

To facilitate comparison, the following indicator, herein named Priority Factor (*PF*), has been calculated for each cell of the Identification of Priority Matrix, when gathering the results:

$$PF = \sum_{i=1}^{N} PF_i = \sum_{i=1}^{N} \frac{1}{X_i}$$

Where N is the number of participants in each group and *X* is the mark assigned to that element of the matrix (from 1 to 3). When the element was left null, then a PF_i equal to zero was attributed. By means of this definition, the most "relevant" example user cases are identified by means of a higher PF. In the following sections, the PF has been calculated for all the elements in the Priority Matrix for groups of users and no normalisation factor has been applied in the corresponding plots.

3.2.2.1 PRIORITIES PER GROUP OF USERS

In this section, the "Identification of priorities" matrices were postprocessed per group of users. The priority factors were calculated, and the outcomes displayed against the Level of Aggregation (Array, Device, Subsystems) and the Type of Tools (Structured Innovation Tools, Stage Gate Tools and Deployment Tools). The Assessment Tools are used by all the other tools and will therefore be demonstrated concurrently.

WAVE ENERGY TECHNOLOGY DEVELOPERS

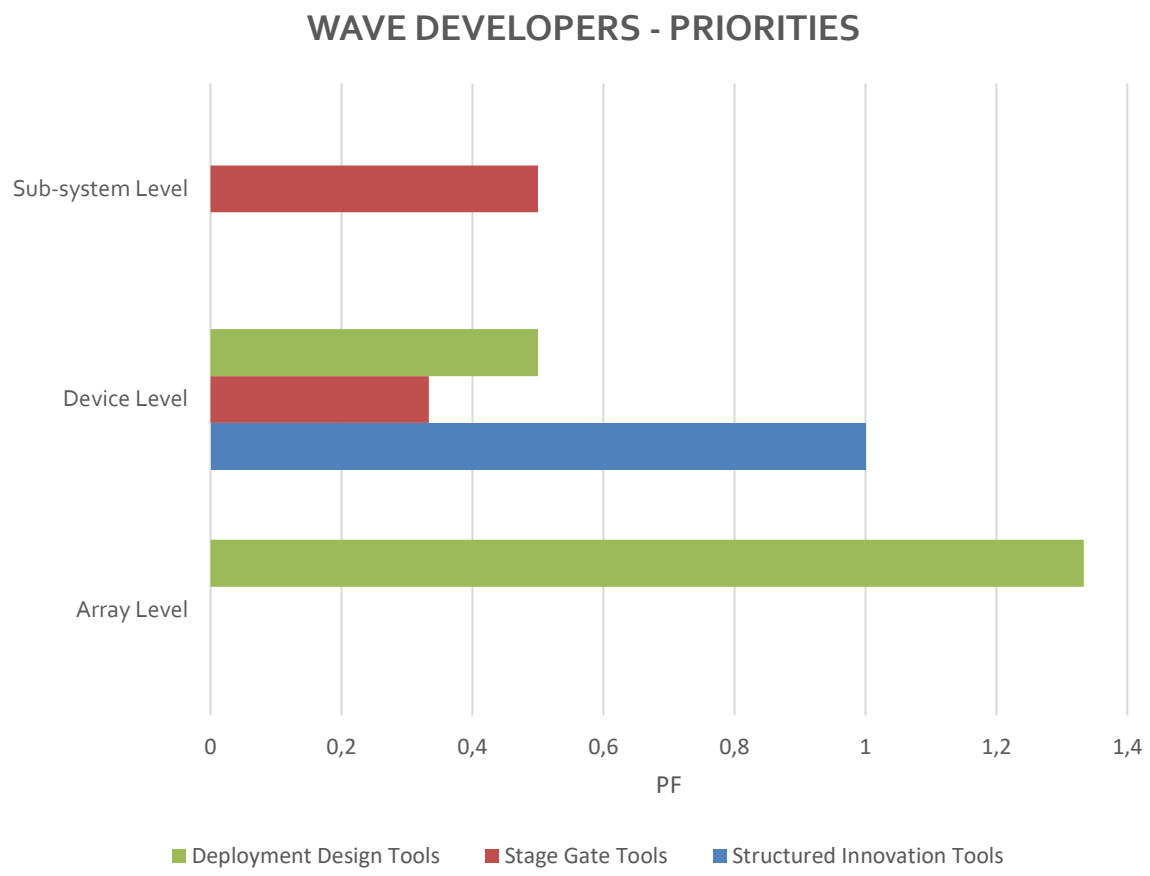

FIGURE 3-4. CUMULATIVE PRIORITY FACTOR FOR DEVELOPERS OF WAVE ENERGY TECHNOLOGIES.

As it could be seen in Figure 3-4, the Wave Energy Technology developers (CorPower and IDOM) assigned the highest *PF* to a potential scenario by using the Deployment Tools for arrays. The same users consider also relevant a scenario involving use of Structured Innovation Tools focusing the attention to innovations for the Device, whereas the Stage Gate Tools seems to be appealing at Subsystem Level.

TIDAL ENERGY TECHNOLOGY DEVELOPERS

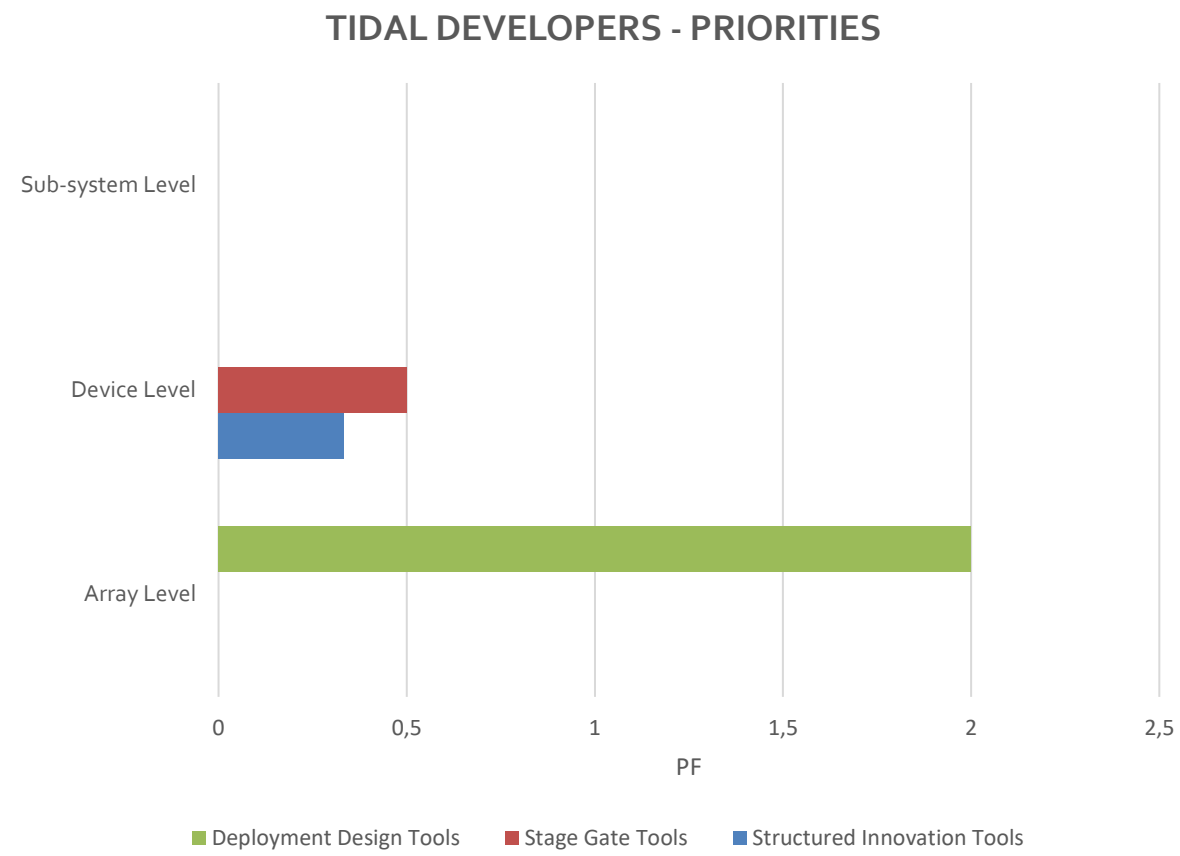

FIGURE 3-5. CUMULATIVE PRIORITY FACTOR FOR DEVELOPERS OF TIDAL ENERGY TECHNOLOGIES.

In the case of tidal, it is worth considering that Nova has expressed just one preference. As it could be seen in Figure 3-5, the Tidal Energy Technology developers (Nova and Orbital) assigned the highest PF to a potential scenario by using the Deployment Tools for arrays. The same users, also, consider relevant a scenario by using the Structured Innovation Tools and Stage Gate Tools focusing the attention to innovations for the Device.

TECHNOLOGY DEVELOPERS (CUMULATIVE WAVE+TIDAL)

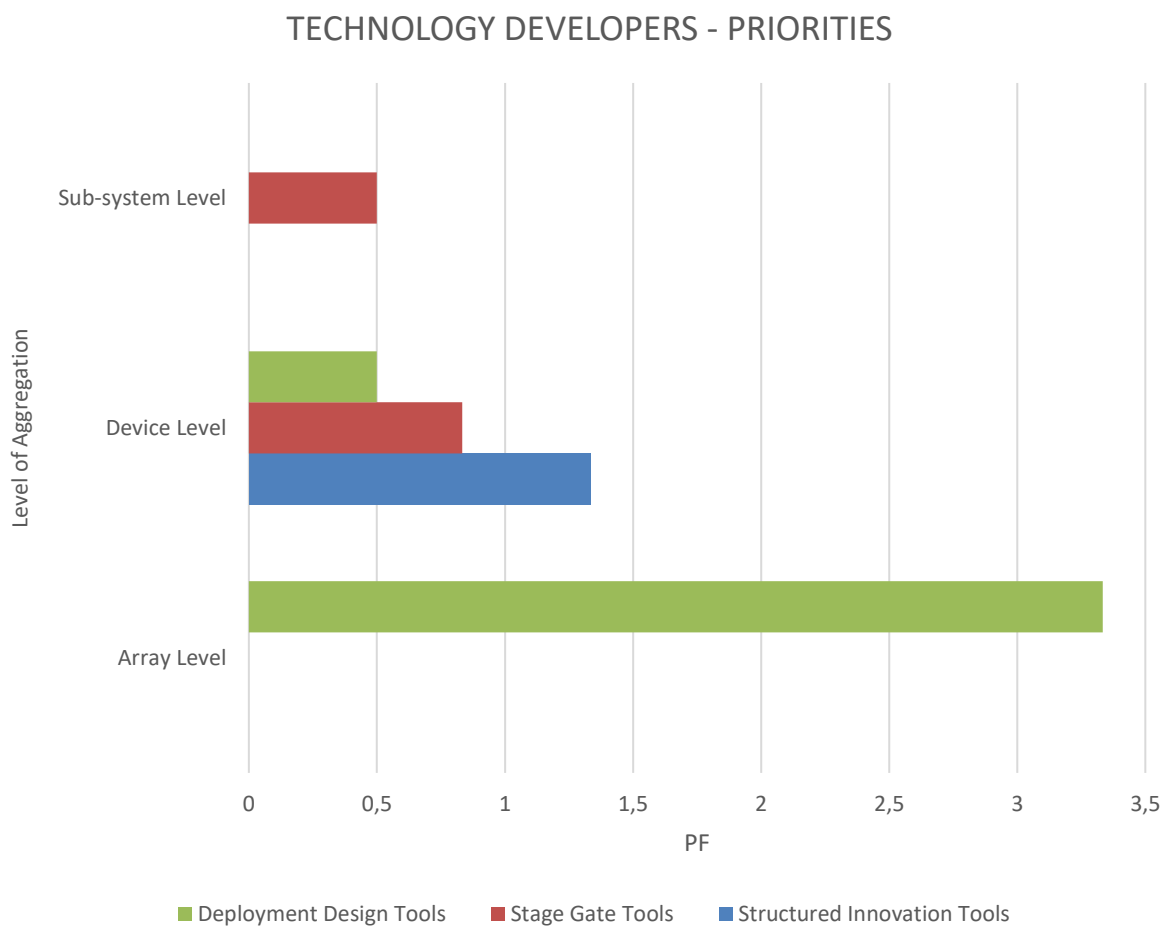

FIGURE 3-6. CUMULATIVE PRIORITY FACTOR FOR DEVELOPERS OF OCEAN ENERGY TECHNOLOGIES.

Globally, the Technology Developers have expressed their preference for a validation scenario using the Deployment Tools for an array of devices, as can be identified in Figure 3-6. At Device level, scenarios considering the Stage Gate Tools and/or the Structured Innovation Tools are appealing. At Subsystem level of aggregation, the Stage Gate Tools seems to be the most preferred option, as neither the Deployment Tools, nor the Structured Innovation tools were chosen among the three most important choices for technology developers.

PROJECT DEVELOPERS

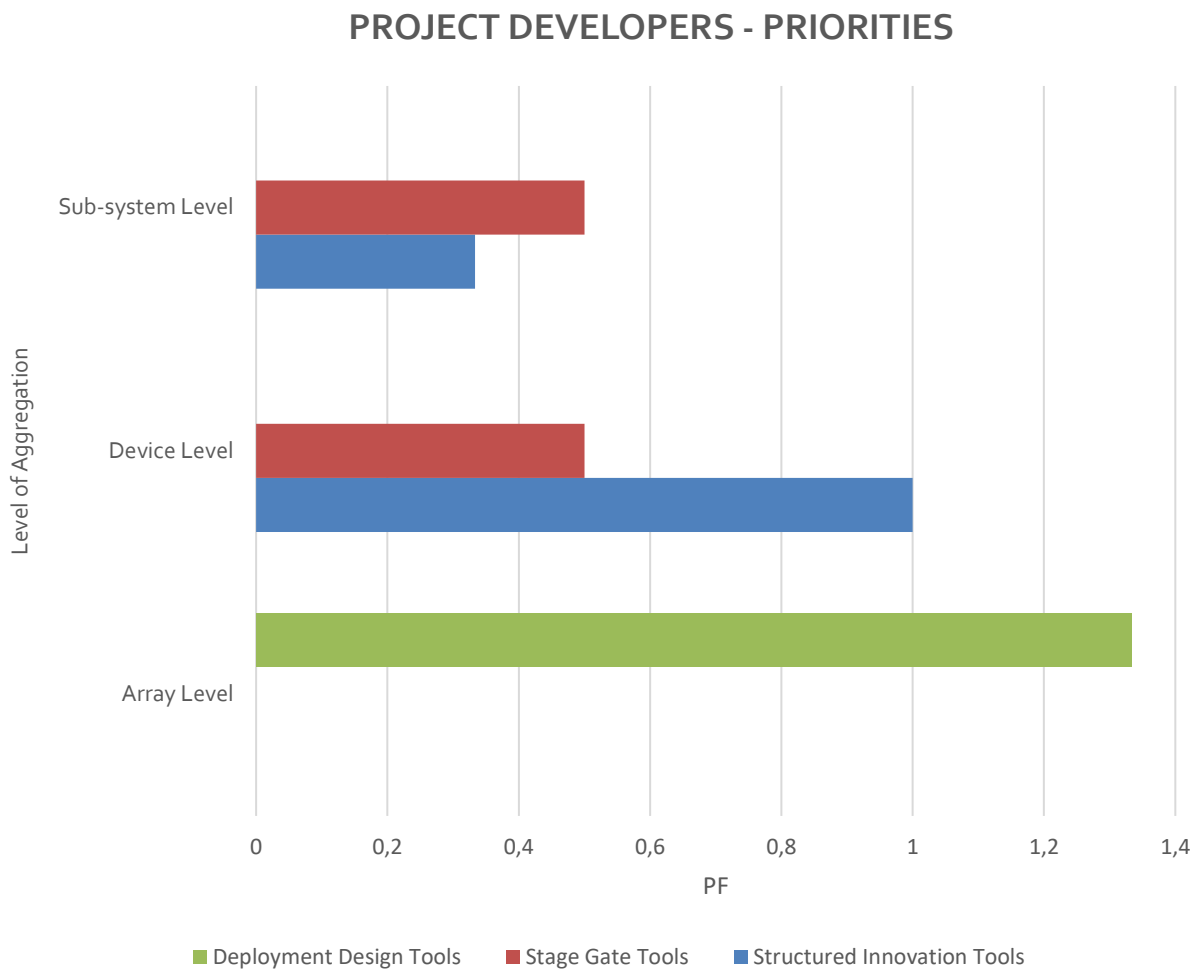

FIGURE 3-7. CUMULATIVE PRIORITY FACTOR FOR DEVELOPERS OF OCEAN ENERGY PROJECTS.

Similarly, to the Technology Developers, the Project Developers (EDF and EGP) have expressed their preferred scenario as an Array Case studied by using Deployment Design tools, as can be seen in Figure 3-7. Again, the Structured Innovation Tools seems to be appealing for a scenario based on device level of aggregation, while the Stage Gate Tools obtain the same Priority Factor for both Device and Subsystem Level.

OTHER KEY USERS PROFILES

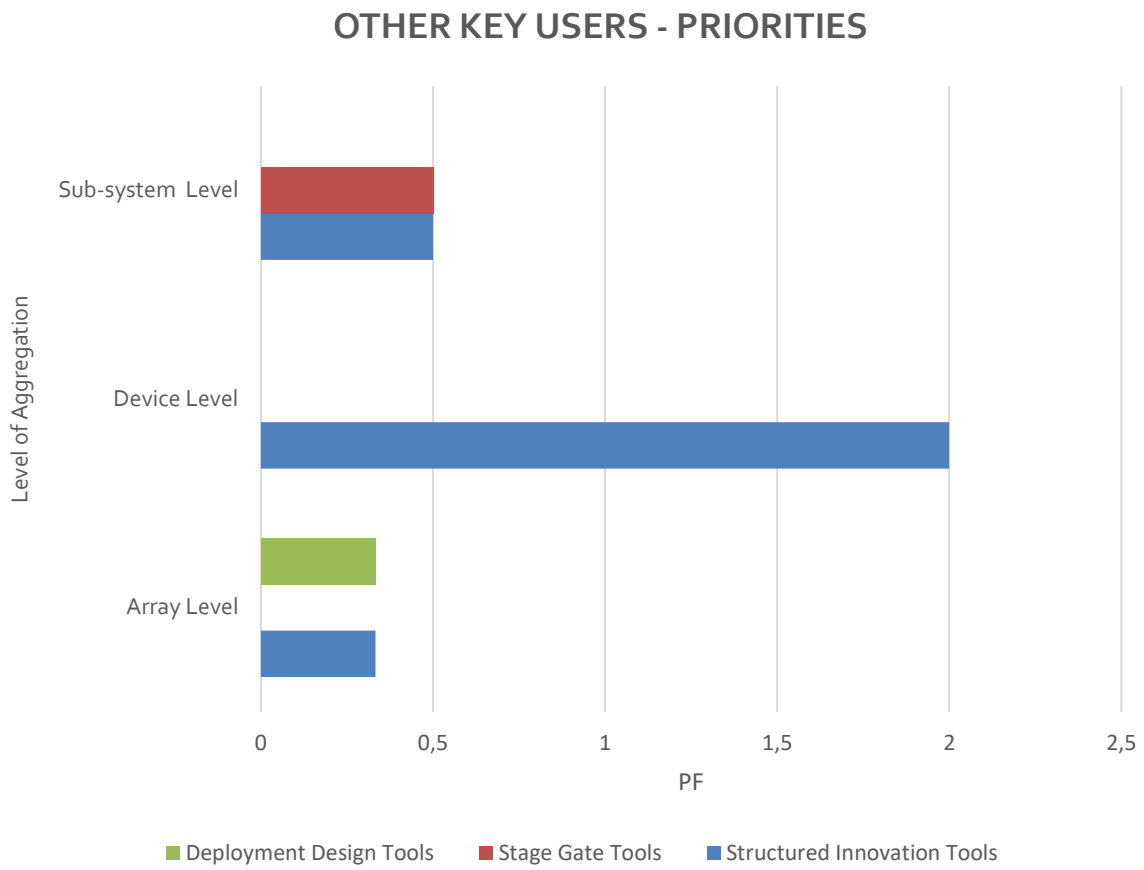

FIGURE 3-8. CUMULATIVE PRIORITY FACTOR FOR DEVELOPERS OF OTHER KEY USERS PROFILES.

The group "Other Key Users Profiles" is made of two different not homogeneous institutions, with different results. This can explain the spreading in the outcomes. It is noteworthy that ESC selected all scenarios based on the Structured Innovation Tools, that they are developing. At array level, both the Structured Innovation tools and the deployment tools seem to be good options for a validation scenario (see Figure 3-8). At Subsystem level, on the contrary the Structured Innovation and Stage Gate Tools are of interest for a potential scenario, while at device level, the highest Priority Factor is obtained by a validation scenario running the Structured Innovation tools.

GLOBAL RESULTS

The global results are shown in Figure 3-9.

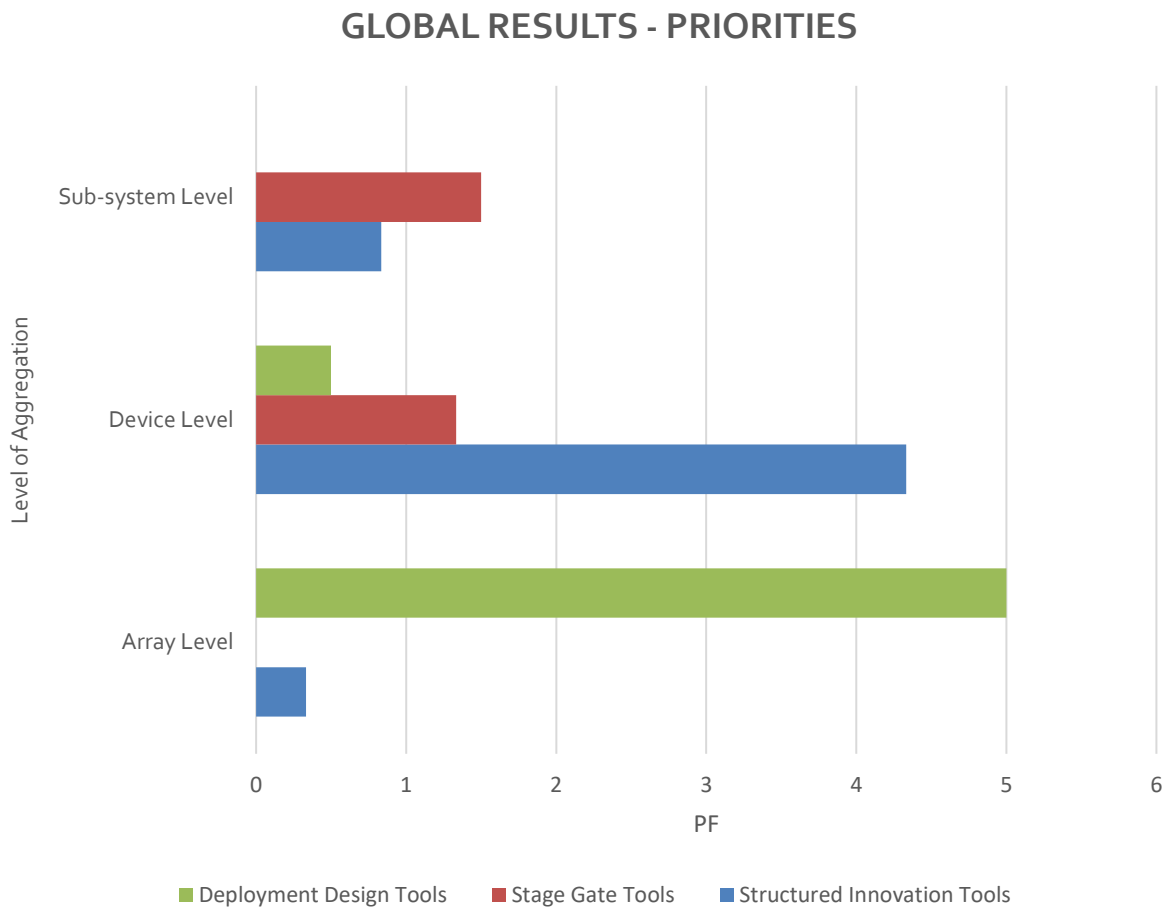

FIGURE 3-9. CUMULATIVE PRIORITY FACTOR FOR THE FULL SAMPLE OF RESPONDENTS.

The validation scenarios that the full sample of respondents considered of interest are the following:

- At array level, the use of Deployment tools represents by far the most preferred option.
- Similarly, at Device level, the use of Structured Innovation tools seems to be more relevant than other scenarios;
- Finally, at Subsystem level, the use of Stage Gate tools represents the most preferred scenario.

It is worth considering that, even if some spreading is identified, the groups of participants in the survey have achieved similar conclusions.

3.2.2.2 PRIORITIES PER TYPE OF TOOLS

In this section, the same outcomes were analysed per type of tools.

PRIORITY FACTORS FOR THE STRUCTURED INNOVATION TOOLS PER USER TYPOLOGY

By analyzing the results in Figure 3-10, all the user groups agree on defining a validation scenario using the Structured Innovation Tools at Device level.

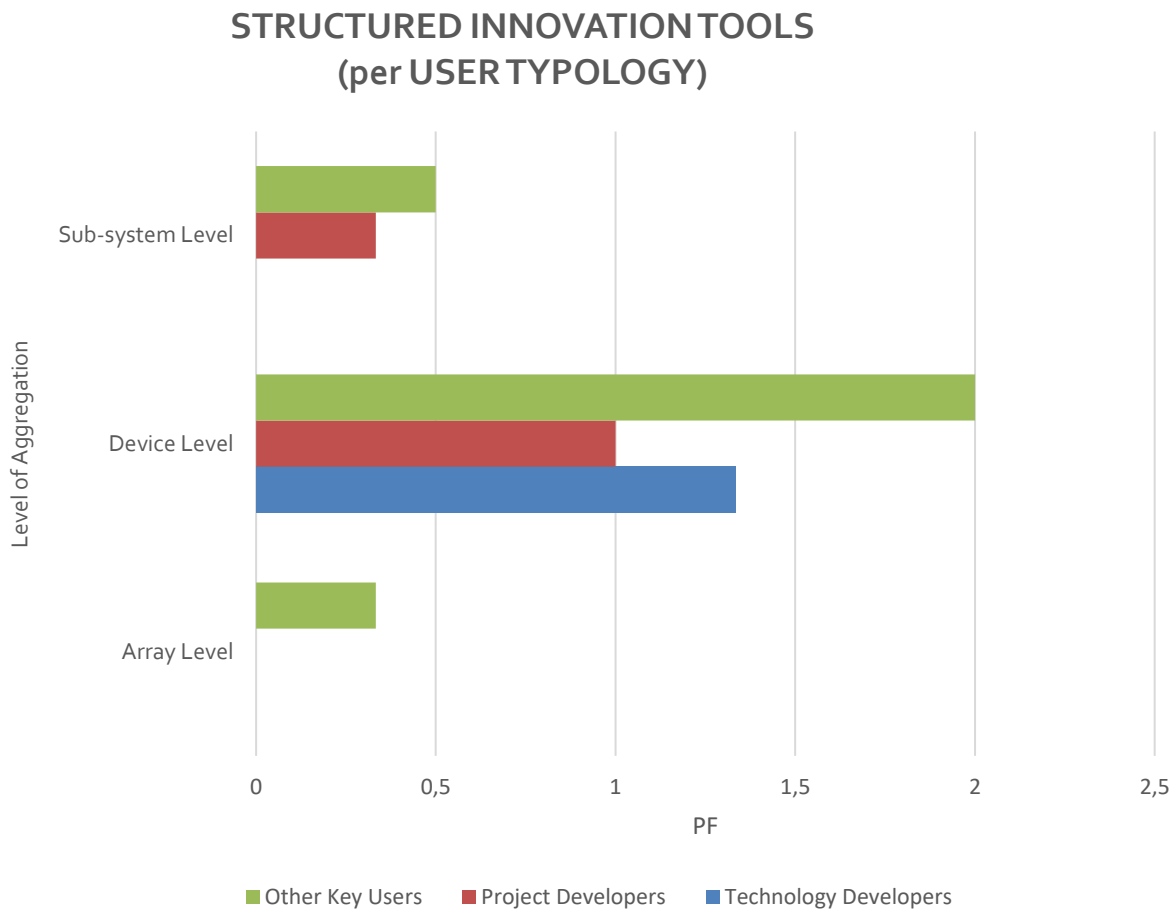

FIGURE 3-10. CUMULATIVE PRIORITY FACTOR FOR THE STRUCTURED INNOVATION TOOLS PER USER TYPOLOGY.

PRIORITY FACTORS FOR THE STAGE GATE TOOLS PER USER TYPOLOGY

A scenario involving the Stage Gate tools, as it could be seen in Figure 3-11, seems to attract the user attention for a validation scenario especially at Subsystem level, and in this case the Priority Factor is uniform through the different typologies of users. However, looking at the Figure 3-11, the Technology Developers, as well as the Project Developers also see the use of Stage Gate Tools to be important at Device Level.

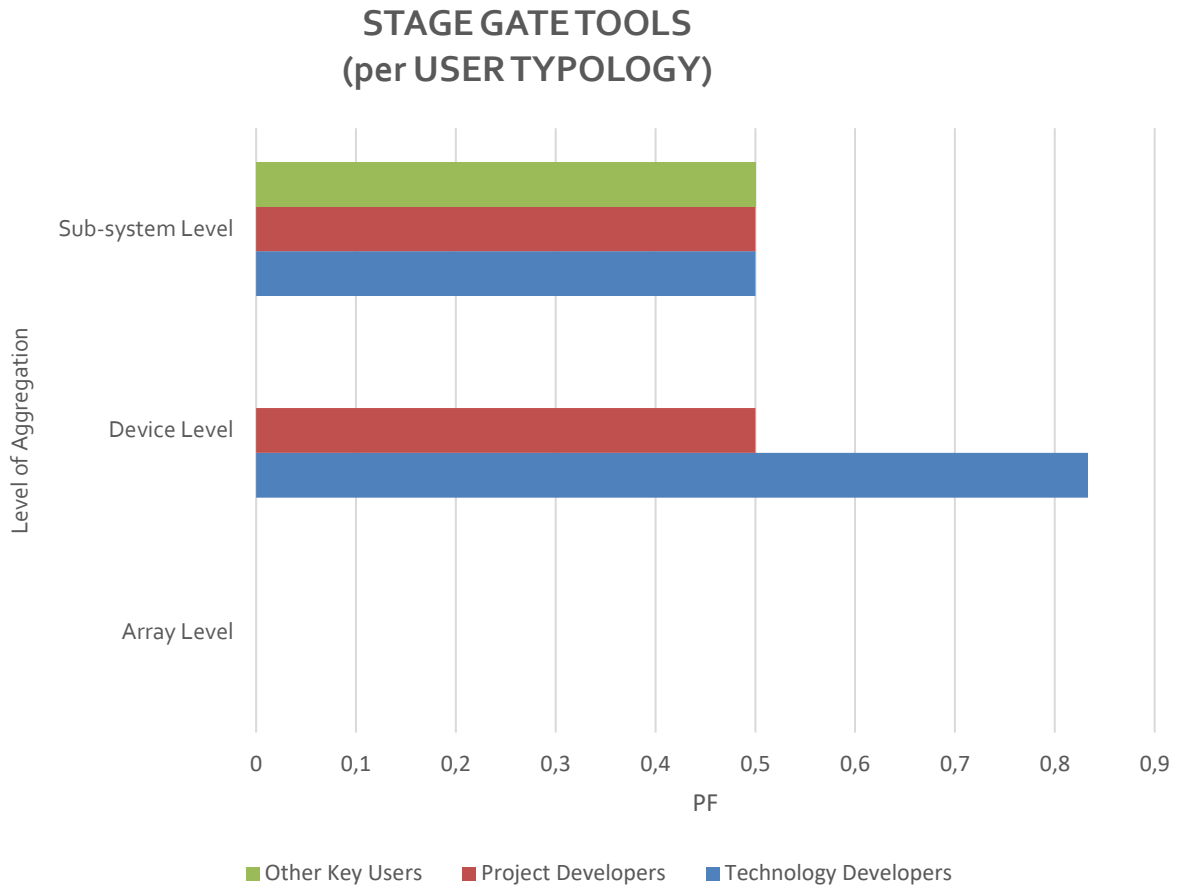

FIGURE 3-11. CUMULATIVE PRIORITY FACTOR FOR THE STAGE GATE TOOLS PER USER TYPOLOGY.

PRIORITY FACTORS FOR THE DEPLOYMENT DESIGN TOOLS PER USER TYPOLOGY

In this case, the results are less spread. All typologies of users consider important a validation scenario using the Deployment Tools at array level, as can be seen from Figure 3-12.

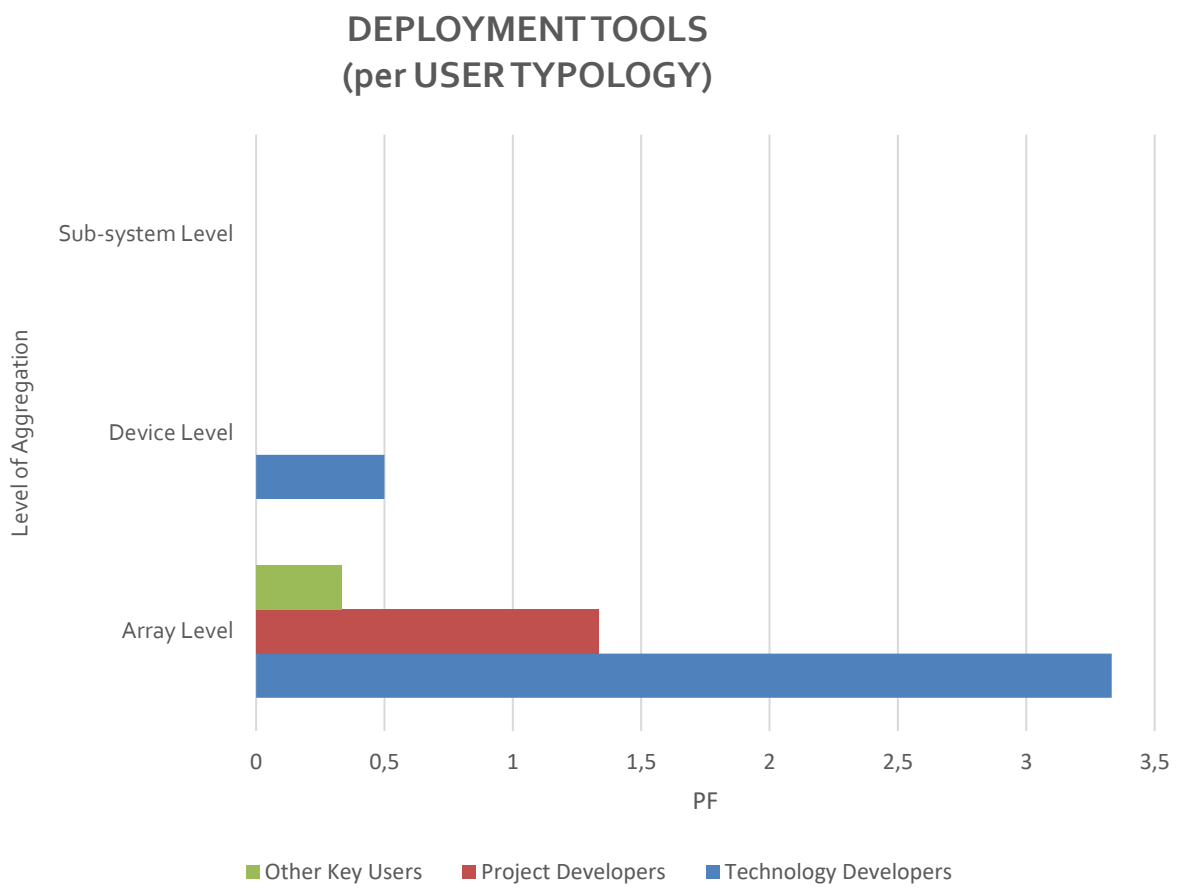

FIGURE 3-12. CUMULATIVE PRIORITY FACTOR FOR THE DEPLOYMENT DESIGN TOOLS PER USER TYPOLOGY.

3.2.2.3 PRIORITIES PER LEVEL OF AGGREGATION

In this section, the Priority Factor has been examined per level of Aggregation.

PRIORITY FACTORS FOR THE AGGREGATION LEVEL "ARRAY" PER USER TYPOLOGY

When considering a scenario involving an array, the user has by far preferred the use of Deployment Tools (see Figure 3-13). This consideration is well shared among the three groups of users identified in the survey.

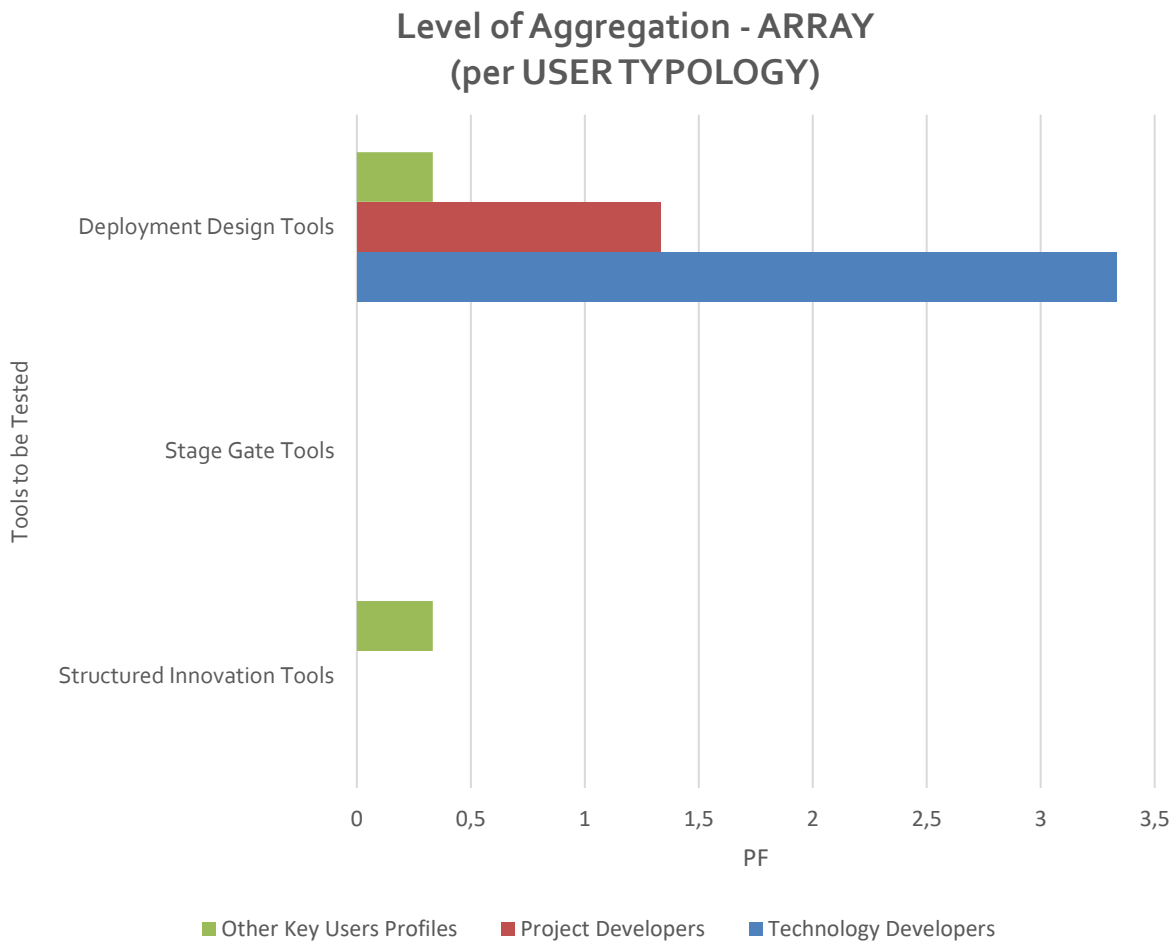

FIGURE 3-13. CUMULATIVE PRIORITY FACTOR FOR THE LEVEL OF AGGREGATION "ARRAY" PER USER TYPOLOGY.

PRIORITY FACTORS FOR THE AGGREGATION LEVEL "DEVICE" PER USER TYPOLOGY

When considering a scenario involving a Device, the group of Users participating to the survey have expressed their preference in using the Structured Innovation Tools (see Figure 3-14). However, also validation scenarios using the Stage Gate Tools seem to be attractive to a certain extent, especially for Project and Technology Developers, while the use of Deployment Design Tools is not foreseen as of high interest for analysing a single device.

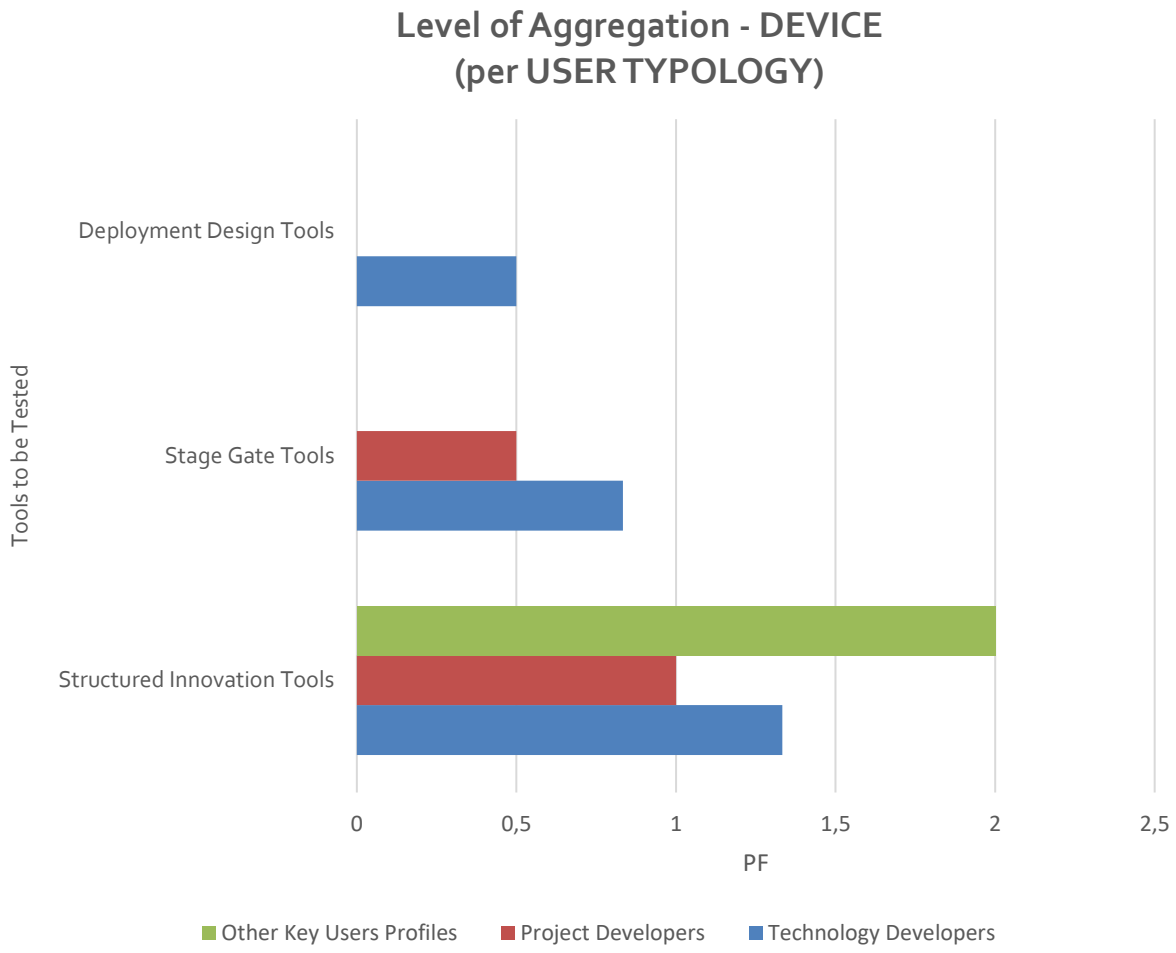

FIGURE 3-14. CUMULATIVE PRIORITY FACTOR FOR THE LEVEL OF AGGREGATION "DEVICE" PER USER TYPOLOGY.

PRIORITY FACTORS FOR THE AGGREGATION LEVEL "SUBSYSTEM" PER USER TYPOLOGY

Finally, while considering a scenario involving subsystems, it seems that the use of Stage Gate tools reaches a uniform consensus throughout the groups in the survey (see Figure 3-15); a validation scenario at level of aggregation subsystem, however, would be of interest also for project developers and for the other key users involved in the survey.

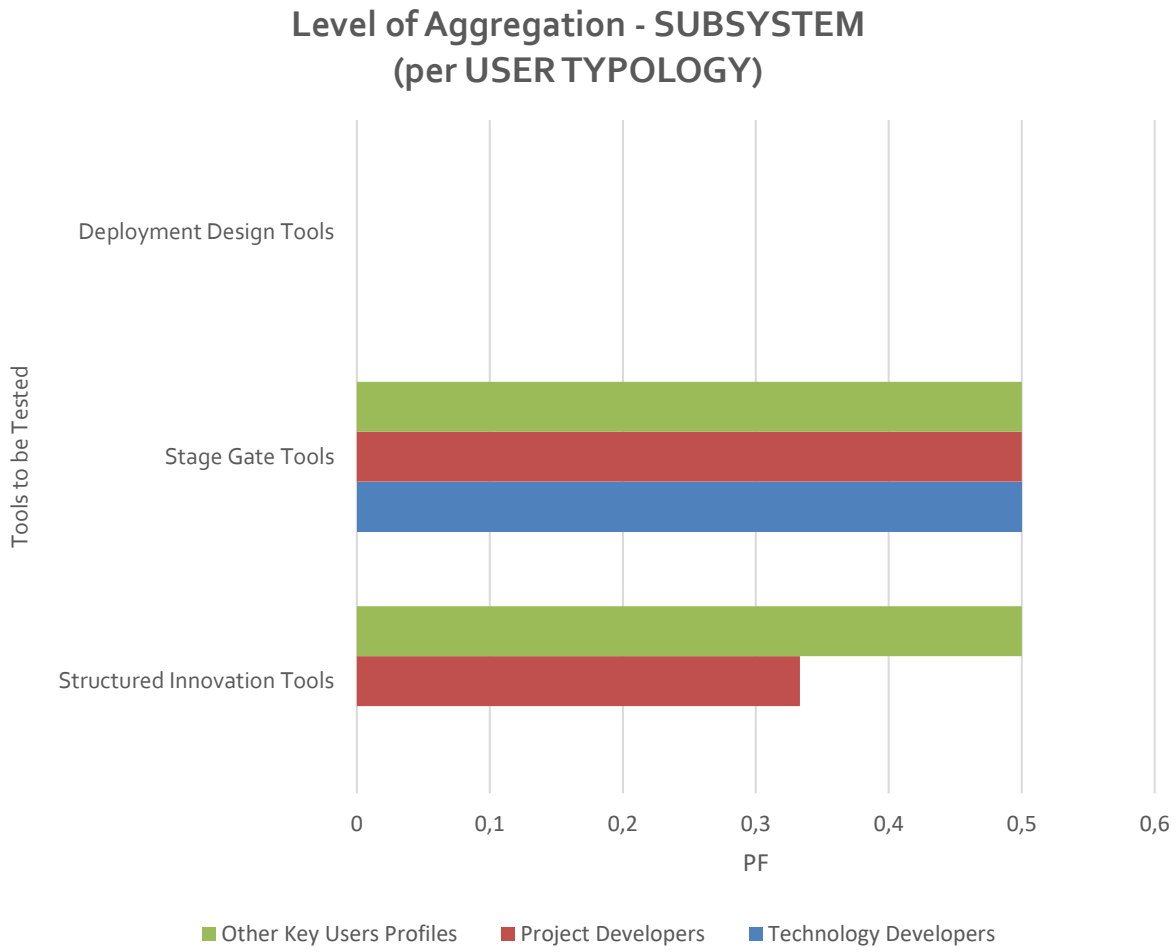

FIGURE 3-15. CUMULATIVE PRIORITY FACTOR FOR THE LEVEL OF AGGREGATION "SUBSYSTEM" PER USER TYPOLOGY.

3.3 CONCLUSIONS AFTER THE BRAINSTORMING AND THE SURVEY

By comparing the outcome of the brainstorming and the survey within the consortium members, some general conclusions could be inferred:

- **Deployment Design Tools**: The use of these tools is highly envisaged at Array Level. This is aligned with the outcome of the brainstorming and it is consistent with the expectations of the project, in which the Deployment tools are tools for the global evaluations of coupled and more complex systems.

- **Stage Gate Design Tools**: There is not an agreement between the Brainstorming at the PSC meeting and the survey. The Stage Gate Tools, indeed, seemed to be a valuable set of tools while assessing the performance of an ocean energy system especially at the device level of aggregation during the PSC meeting. However, the technology developers in the consortium, as well other key users such as ESC and project developers as EGP, consider that a scenario involving the Stage Gate Tools is more relevant at Subsystem Level.
- **Structured Innovation Design Tools**: Again, when considering validation scenarios involving these kind of tools, during the PSC meeting a consensus was achieved that this set of tools was useful to investigate scenario at Subsystem Level. However, during the survey it emerged that the Technology developers, as well other key users such as ESC and project developers as EGP, consider more important scenarios involving the Structured Innovation Tools at Device Level.

The procedure of refinement of priorities has been useful to further focus on the real needs of the sector, as well as to identify gaps and differences in the views that have not emerged during the PSC meeting. Accounting for all the above, the following Section presents a refined proposal for Validation Scenarios, aimed at representing and covering the most relevant and important use cases.

4. PROPOSED VALIDATION SCENARIOS

In this section, a final proposal for Validation Scenarios is presented, considering the outcome of the Brainstorming (see Section 3.1) as well as the Internal Survey (see Section 3.2).

The minimum requirements for the validation scenarios are those defined in the Description of Action document:

- At least two sites should be considered, one for wave and one for tidal technology;
- At least four technologies should be validated, i.e. the ones developed by the four Technology Developers part of the DTOceanPlus consortium. Two of them are Wave Energy technologies and two of them are Tidal Energy technologies.
- All the toolsets should be validated: the Structured Innovation tools, the Stage Gate tools and the Deployment design tools. The Assessment tools are transversal and used by all the other tools.

While analysing the results and given the wide spectrum of example use cases and objectives, it seemed appropriate to limit the number of representative Validation Scenarios to a number equal to 6. Indeed, each validation case would require a significant burden in terms of data collection. For this reason, some validation scenarios were paired such that they could use a common framework of technology, intended site, and catalogue of components and services. These common frameworks could then be used by different tools to achieve different objectives while accomplishing with the minimum requirements for T2.3, significantly reducing the burden of data collection and still covering the Matrix of User and Tools.

The Validation Scenarios characteristics are proposed as in Table 4.1.

TABLE 4.1. PROPOSED VALIDATION CASES.

Validation Scenario	Technology	Level of Aggregation	Set of Tools to Validate	Related to another VS
VS1	Wave	Device	Structured Innovation	VS2
VS2	Wave	Subsystem	Stage Gate	VS1
VS3	Wave	Array	Deployment	-
VS4	Tidal	Subsystem	Structured Innovation	VS5
VS5	Tidal	Device	Stage Gate	VS4
VS6	Tidal	Array	Deployment	-

The matrix in Table 4.1 can be visualised in Figure 4-1. It is evident that all the tools will be validated both for wave and tidal technology, with different level of aggregation. The choice of the aggregation level was proposed accounting for the outcome at the brainstorm in Paris and the internal survey.

		Tools to be Tested					
		Structured Innovation Tools		Stage Gate Tools		Deployment Design Tools	
		Wave	Tidal	Wave	Tidal	Wave	Tidal
Level of Aggregation	Array Level					VS3	VS6
	Device Level	VS1			VS5		
	Sub-system Level		VS4	VS2			

FIGURE 4-1. PROPOSED VALIDATION SCENARIO MATRIX.

In the following sections, a more detailed description of the scenarios is presented. When possible, the technology and intended site will be identified, as well as potential criticalities, such as the availability of the data. Similarly, for each validation case a set of objectives has been specified, in order that the needs of more than one potential user type can be accommodated.

4.1 VALIDATION SCENARIO 1: WAVE / SI TOOLS / DEVICE LEVEL

VS1 is representative for a **Wave Technology**, using the **Structured Innovation Tools** at **Device level**.

CorPower has identified this validation scenario as the most relevant for their technology. The objective of this validation scenario is "to rapidly evaluate different system-level concepts and to identify the most promising investment potential to reach performance targets at the least possible cost., to "identify attractive areas of innovation to improve within its technology", besides "creating new or improving a device concept". Similarly, **EGP** has expressed its maximum interest in this scenario, to carry out a gap analysis and identify enabling technologies.

While EGP did not provide information about the Technology to test, CorPower suggested to validate the tool using its own technology at a site to be defined, e.g. **Billia Croo, Agucadoura**. EGP suggested to use a site in **Chile**. Both EGP and CorPower declared to have available information about the site at intermediate level. However, the technology, as well as catalogue of services and components are described at a basic level. This could represent a bottleneck; however, the use of Structured Innovation tools, generally used at early stage during the lifetime of a project, make the requirements in terms of data less demanding.

This validation scenario represents also the most attractive scenario for **WES**. The objective proposed by WES in this validation scenario is different. Indeed, the validation scenario will be run towards the definition "of a new wave energy concept. [...] this is important as it will demonstrate the potential of the Structured Innovation tool and will require the use of all of the tools: TRIZ, QFD and FMEA in the process." In order to test the full functionality of the tool, the VS should cover both the "improvement cycle" and "concept creation" parts of the Structured Innovation. This is a VS which is therefore multi-objective, as it will cover the needs of technology developers, project developers and institutions dedicating efforts towards the acceleration of the wave energy sector.

A summary of the Validation Scenario 1 is proposed in Table 4.2.

TABLE 4.2. SYNOPTICAL DESCRIPTION OF VS1.

VALIDATION SCENARIO 1	
Technology Type	Wave
Tools to be Validated	Structured Innovation
Aggregation Level	Device Level
Lead Partner	CorPower
Other Partners Interested	EGP, WES
Technology	CorPower Ocean- C4
Total Power / Number of Devices	300 kW - 1 device
Subsystem/Component	n/a
Intended Site	Billia Croo Agucadoura; Chile?

4.2 VALIDATION SCENARIO 2: WAVE / SG TOOLS / SUBSYSTEM LEVEL

This Validation Scenario is related to the Validation Scenario 1, and therefore it is representative of a **Wave Energy technology**. The same benchmark (Technology, Intended Site and Catalogues) of VS1, indeed, could be used. In this case, however, the **Stage Gate Tools** will be validated at a **subsystem** level.

This Validation Case represents the second in order of interest for the Wave Energy developer **CorPower**, aiming at a comparison with standard benchmarks/ threshold (progression to next stage) (LCOE/other) and assessing areas of compliance & non-compliance, as well as identify what needs to be done to meet the next stage. However, no preference in terms of the subsystem to investigate was identified. For **EGP**, this validation case also represents the second in terms of interest. Likewise, the objective is to identify when to upscale (transition points) and assess when to move between different stages of development (e.g. prelim. study > feasibility > detailed design).

WES, similarly, considers this validation case of interest also for assisting a generic private investor in investment decisions. "The User Case would be taking the data from the validation testing (real sea deployment) and using it to assess the technology against a default stage gate metrics framework, to assess the stage of the technology and the steps to reach the next stage".

Neither CorPower nor EGP and WES have expressed preference for the subsystem to analyse: any PTO, prime mover, control system or moorings and foundations could be used for the scenario. However, one potential choice for CorPower would be to consider the mooring system as objective for this validation scenario, WES suggests that perhaps a PTO is the sensible choice in terms of industry priority, availability of data and difference from the "device" level of aggregation.

A summary of the Validation Scenario 2 is proposed in Table 4.3.

TABLE 4.3. SYNOPTICAL DESCRIPTION OF VS2.

VALIDATION SCENARIO 2	
Technology Type	Wave
Tools to be Validated	Stage Gate
Aggregation Level	Subsystem Level
Lead Partner	CorPower
Other Partners Interested	EGP, WES
Technology	CorPower Ocean – C4
Total Power / Number of Devices	300 k W - 1 device
Subsystem/Component	Mooring System - PTO
Intended Site	Billia Croo Agucadoura; Chile?

4.3 VALIDATION SCENARIO 3: WAVE / DEPLOYMENT TOOLS / ARRAY LEVEL

VS3 is representative for a **Wave Technology**, using the **Deployment Design Tools** at **Array level**.

IDOM has identified this validation scenario as the most relevant for their technology. The objective of this validation scenario is the "evaluation of CAPEX and OPEX cost figures for the cell-type array in a specific location". The technology used to validate the toolset is a cell-type array of the technology developed by IDOM; in an array of **8 devices** for a total nominal rated power of **2 MW**. The Intended location is **BiMEP**. The level of data availability in terms of technology and site characterisation is "detailed", while the catalogues are defined at an intermediate level of detail.

EGP consider this as the third relevant case of interest. The objective is to assess how a device/technology works in an array cf. individual device, to provide evidence for marketing/investment and assess how the device/technology performs/behaves with different locations & balance of plant. EGP did not provide information about the technology to test, or about the location.

This validation scenario represents the third in terms of interest for **CorPower** and for WES. In case of WES, the objective will be, besides those identified by EGP and IDOM, to optimise size/scale/balance of plant in the array as well as planning deployment and O&M. WES sees in this scenario a good opportunity to validate the deployment design tools using realistic data.

The choice of the number of WECs for the benchmark is still to be defined: the number of devices proposed by WES is 3.

A summary of the Validation Scenario 3 is proposed in Table 4.4.

TABLE 4.4. SYNOPTICAL DESCRIPTION OF VS3.

VALIDATION SCENARIO 3	
Technology Type	Wave
Tools to be Validated	Deployment Design
Aggregation Level	Array Level
Lead Partner	IDOM
Other Partners Interested	EGP, WES
Technology	MARMOK- A14
Total Power / Number of Devices	2MW / 8 devices
Subsystem/Component	n/a
Intended Site	BiMEP

4.4 VALIDATION SCENARIO 4: TIDAL / SI TOOLS / SUBSYSTEM LEVEL

This Validation Scenario is related to the Validation Scenario 5. It is representative of a **Tidal Energy technology** and the **Structured Innovation Tools** will be validated at a **subsystem** level.

Orbital Marine Power has identified a validation scenario using the Structured Innovation Tools as the third most relevant for their technology, even if their preferred option is to deal with a subsystem level of aggregation. However, **EDF**, considers this as a good opportunity to improve wet-mate connectors to be used in a commercial tidal farm. Moreover, other objectives of this validation case are to use the tools to structure their decision making regarding which options of device enhancement to progress, with respect to engineering investment, LCoE improvement, timescales, societal acceptance issues, etc.

Orbital would like to validate the tool using the Orbital O2 2 MW device, at a site which could be **EMEC Berth 5.** Both the technology description, as well as the site characterisation are available at a detailed level. Also, the catalogues are described at a detailed level. EDF has shown no preference on the technology, but for the intended site the preferred option is **Raz-Blanchard**. The site characterisation for this site is at an intermediate level of detail.

ESC also considers this as a relevant scenario to improve for example simplification or cost reduction, but still maintaining the design features which are critical to success. No specific technology was identified.

The choice of the number of turbines for the benchmark still is to be defined: EDF aims at a scenario involving 100 turbines, while Orbital would focus on just one device.

The choice of the intended site still is to be defined, according to the availability of the data.

A summary of the Validation Scenario 4 is proposed inTable 4.5.

TABLE 4.5. SYNOPTICAL DESCRIPTION OF VS4.

VALIDATION SCENARIO 4	
Technology Type	Tidal
Tools to be Validated	Structured Innovation
Aggregation Level	Subsystem Level
Lead Partner	Orbital Marine Power
Other Partners Interested	EDF, ESC
Technology	Orbital O2; 2 MW
Total Power / Number of Devices	1 device? 100 devices?
Subsystem/Component	Connectors
Intended Site	EMEC Berth 5; Raz-Blanchard

4.5 VALIDATION SCENARIO 5: TIDAL / SG TOOLS / DEVICE LEVEL

VS5 is representative for a **Tidal Technology**, using the **Stage Gate Tools** at **Device level**.

Orbital Marine Power has identified this validation scenario as the second most relevant for their technology. The objective of this validation scenario is "to support decision regarding the adoption of enhancements to Orbital O2 2MW device. The use of the Stage Gate Tools of DTOceanPlus will support the decision-making process of enhancement engineering readiness, the impacts and cost / risk implications". The same benchmark (Technology, Site and Catalogues) of VS4, indeed, could be used.

The technology will consist in the **Orbital O2 device**, focusing the attention on the drivetrain scaling. The intended site could be **EMEC Berth 5**. Indeed, both the technology description, as well as the site characterisation is available at a detailed level. Also, the catalogue will be described at a detailed level.

EDF assigns at this scenario an important level of interest, being the second choice. The purpose of this validation scenario would be to "assess the stage at which a tidal technology is and what needs to be done to meet commercial performance in an array". While no preference on the technology is expressed, as for the intended site the preferred option is **Raz-Blanchard**. The site characterisation for this site is at an intermediate level of detail.

The choice of the intended site still is to be defined, according to the availability of the data.

A summary of the Validation Scenario 5 is proposed in Table 4.6.

TABLE 4.6. SYNOPTICAL DESCRIPTION OF VS5.

VALIDATION SCENARIO 5	
Technology Type	Tidal
Tools to be Validated	Stage Gate
Aggregation Level	Device Level
Lead Partner	Orbital Marine Power
Other Partners Interested	EDF
Technology	Orbital O2; 2 MW
Total Power / Number of Devices	1 device? 10 devices?
Subsystem/Component	drivetrain scaling
Intended Site	EMEC Berth 5; Raz-Blanchard

4.6 VALIDATION SCENARIO 6: TIDAL / DEPLOYMENT TOOLS / ARRAY LEVEL

VS6 is representative for a **Tidal Technology**, using the **Deployment Design Tools** at **Array level**.

Nova has identified this validation scenario as the most relevant for their technology. The objective of this validation scenario is to carry out a third party 'validation' of new array projects at various sites, but also to assess how their device/technology works in an array compared against an individual device and provide evidence for marketing/investment. The technology to be used for validating the Deployment tools is the **Nova M100DD**, in an array of **ten 100kW tidal turbines**. The intended site could be **Bluemull or Bardsey.** Also, **Orbital** has shown interest for this validation scenario, considering 5 devices of the technology Orbital O2 2 MW.

The technology and the site are available at a level of detail "intermediate", while the catalogues are available with a basic level of detail.

This validation scenario represents the most preferred option for validation scenario of **EDF**. The purpose of this validation scenario would be to, besides those declared by Nova, to assist in investment decisions and assess the viability of a commercial tidal farm of **50 turbines** in the **Raz-Blanchard**. The site characterisation for this site is at an intermediate level of detail.

The choice of the intended site and the number of turbines is therefore open, according to the availability of the data.

A summary of the Validation Scenario 6 is proposed in Table 4.7.

TABLE 4.7. SYNOPTICAL DESCRIPTION OF VS6.

VALIDATION SCENARIO 6	
Technology Type	Tidal
Tools to be Validated	Deployment Design
Aggregation Level	Array Level
Lead Partner	NOVA (also Orbital showed interest)
Other Partners Interested	EDF
Technology	Nova M100DD – 100 kW or more advanced one if available – (Orbital O2 2 MW)
Total Power / Number of Devices	Nova recommends 10-50 devices (Orbital suggested 5 devices)
Subsystem/Component	N/A
Intended Site	Bluemull; Bardsey; Raz-Blanchard (Orbital suggested Morlais demonstration zone)

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5. CONCLUSIONS

This report has described the process which has been followed for the identification of a set of Validation Scenarios (also called demonstration scenarios) to run the tools developed in the project DTOceanPlus. Given the complexity of the tools being developed in the DTOceanPlus project, there are many potential validation scenarios. With three design tools (Structured Innovation, Stage Gate, and Deployment, all using the Assessment tools), three levels of complexity (Array, Device, and Subsystem), and two technology types (wave and tidal) there could be at least 3×3×2=18 cases. There are also three main categories of users (Technology Developers, Project Developers, and Public and Private Investors), so it is therefore not practicable to validate all permutations.

In this study, six validation scenarios have been identified, three of them involving at least two wave technologies, and three of them involving at least two tidal technologies. Similarly, various alternatives for deployment sites have been proposed, at least one for tidal and one for wave scenarios. All the tools will be validated: Structured Innovation Tools, Stage Gate Tools and Deployment Design Tools, while the Assessment Tools will be used by all the other tools.

TABLE 5.1: SUMMARY OF SELECTED VALIDATION SCENARIOS

Ref	Technology	DTOceanPlus tools	Complexity
VS1	Wave	Structured Innovation	Device
VS2	Wave	Stage Gate	Subsystem
VS3	Wave	Deployment	Array
VS4	Tidal	Structured Innovation	Subsystem
VS5	Tidal	Stage Gate	Device
VS6	Tidal	Deployment	Array

The choice of the validation scenarios has been derived and contrasted among all the types of potential users in the DTOceanPlus consortium, in order to guarantee that the chosen set of scenarios is able to show the full capabilities of the software developed and that the expected outcome will be impactful for the Ocean Energy Sector.

These validation scenarios will be reviewed again during T7.2 of the project. At that point, the validation scenarios will be confirmed, eventually updated and finally detailed, accounting for the availability of project data.

6. REFERENCES

[1] D. R. Noble et al., "DTOceanPlus D2.2 Functional requirements and metrics of 2nd generation design tools," DTOceanPlus Consortium, Edinburgh, UK, 2018.

ANNEX A. LIST OF EXAMPLE USER CASES

The Example User Cases, identified in Task 2.2 of the DTOceanPlus project, are the following:

TECHNOLOGY DEVELOPERS USING STRUCTURED INNOVATION DESIGN TOOLS

- UC1.1. Creating new or improving a device concept
- UC1.2. Creating new or improving a sub-system for an existing device
- UC1.3. Identifying enabling technologies required (gap analysis)
- UC1.4. Generating ideas for optimising device: topology/scale(s)/location(s)/market(s)
- UC1.5. Assessing a current technology
- UC1.6. Identifying and quantifying challenges
- UC1.7. Identifying potential areas of opportunity

Inputs: User requirements (e.g. budget, risk, location, etc…) or technology characteristics relating to existing technology

Output: New concepts/ideas

TECHNOLOGY DEVELOPERS USING STAGE GATE DESIGN TOOLS

- UC2.1. Assesses what stage their technology is at including sub-systems and devices
- UC2.2. Comparison with standard benchmarks/ threshold (progression to next stage) (LCOE/other)
- UC2.3. Assessing areas of compliance & non-compliance
- UC2.4. Identify what needs to be done to meet the next stage
- UC2.5. Provide evidence for marketing/investment

Inputs: Technology characteristics

Outputs: Current stage; Steps to meet next stage; or an appropriate answer to the deployment and assessment design tools (energy yield etc.) depending on stage

TECHNOLOGY DEVELOPERS USING DEPLOYMENT AND ASSESSMENT DESIGN TOOLS

- UC3.1. Assess how their device/technology works in an array cf. individual device
- UC3.2. Assess how their device/technology performs/behaves with different locations & balance of plant (either for single device or an array)
- UC3.3. Optimising the size of array and balance of plant for their specific device
- UC3.4. Provide evidence for marketing/investment

Inputs: Site and technology characteristics

Outputs: Outputs from deployment and assessment design tools (energy yield etc.)

PROJECT DEVELOPERS USING STRUCTURED INNOVATION DESIGN TOOLS

- UC4.1. Creating new or improving an array concept
- UC4.2. Identifying areas of opportunity, in terms of topology/scale(s)/ location(s)/market(s) for array/device/subsystem
- UC4.3. Identifying enabling technologies required (gap analysis)
- UC4.4. Identifying types of transition points in terms of array size/scale

- UC4.5. Assessing current arrays/technology
- UC4.6. Identifying and quantifying challenges
- UC4.7. Identifying areas of opportunity
- UC4.8. To get indications on where/how to focus use of the deployment design tools

Inputs: User requirements (e.g. budget, risk, location, etc…)

Outputs: New concepts/ideas

PROJECT DEVELOPERS USING SG

- UC5.1. Assesses what stage their project/array is at
- UC5.2. Identify when to upscale (transition points)
- UC5.3. Identify what needs to be done to meet the next stage
- UC5.4. Assess when to move between different stages of development (e.g. prelim. study > feasibility > detailed design)
- UC5.5. Assess enabling technologies and devices (acting like an investor based on outputs from Stage Gate Metrics)
- UC5.6. Provide evidence for marketing/investment

Inputs: Technology and project characteristics

Outputs: Current stage; steps to meet next stage; or an appropriate answer to the assessment design tools depending on stage

PROJECT DEVELOPERS USING DEPLOYMENT AND ASSESSMENT DESIGN TOOLS

- UC6.1. Assess how a device/technology performs/behaves with different locations & balance of plant (either for single device or an array)
- UC6.2. Optimise size/scale/balance of plant in the array
- UC6.3. Planning deployment and O&M
- UC6.4. Provide evidence for marketing/investment

Input: Site, technology & project characteristics

Output: Suitability of device for site; outputs from deployment design tools

PUBLIC AND PRIVATE INVESTORS USING STRUCTURED INNOVATION DESIGN TOOLS

- UC7.1. Identify attractive areas of innovation for investment
- UC7.2. (Public) Design of funding calls

Inputs: User requirements (e.g. budget, risk, location, etc…)

Outputs: Ideas for investment/funding

PUBLIC AND PRIVATE INVESTORS USING STAGE GATE DESIGN TOOLS

- UC8.1. Assess projects, devices, enabling technologies and (based on outputs from Stage Gate Metrics)
- UC8.2. (Public) Assess if device/technology ready to go to the next stage?
- UC8.3. (Public) Identify R&D opportunities
- UC8.4. (Private) Assist in investment decisions

Inputs: Technology & project characteristics

Outputs: Outputs from assessment design tools

PUBLIC AND PRIVATE INVESTORS DEPLOYMENT AND ASSESSMENT DESIGN TOOLS

UC9.1. Assist in investment decisions

- UC9.2. Due diligence
- UC9.3. Future potential for array expansion

Inputs: Technology & project characteristics

Outputs: Outputs from assessment design tools

ANNEX B. BRAINSTORMING: LIST OF PARTICIPANTS AND PROCEDURE

The participants to the session are reported in Table B.1:

TABLE B.1. LIST OF PARTICIPANTS TO THE BRAINSTORMING ACTIVITY AT THE PSC MEETING.

Name	Partner
Pablo Ruiz-Minguela	Tecnalia
Vincenzo Nava	Tecnalia
Henry Jeffrey	UEDIN
Donald Noble	UEDIN
Stuart Bradley	ESC
Inès Tunga	ESC
Jonathan Hodges	WES
Jillian Henderson	WES
Yann-Hervé de Roeck	FEM
Nicolas Germain	FEM
Mélusine Gaillard	FEM
Francisco Correia da Fonseca	WavEC
Marta Silva	WavEC
Francesco Ferri	AAU
Nicolas Relun	EDF
Jean Baptiste Le Dreff	EDF
Nicolas Larivière-Gillet	BV
Frédéric Pons	OCC

On a whiteboard, a 3×3 grid was painted, representing the three typologies of users (Technology Developers, Project Developers and Private/Public Investors) and the three sets of Tools (Structured Innovation Tools, Stage Gate Tools and Deployment Tools).

Each participant was provided with three differently-coloured post-its, representing the three votes available. Each colour was different, representing three different level of aggregation to be considered within the framework of DTOceanPlus: array (yellow), device (pink) and subsystems (blue). Two polls were carried out, one corresponding to the evaluation of priorities for the definition of scenarios for Wave Energy Technologies and the other one for Tidal Energy Technologies.

Each participant was therefore asked to "vote" the options for the validation cases he or she considered more relevant, for typology of expected user, set of tools to validate and level of aggregation. The user had to attach the post its to the white board to express their vote. If any of them considered one of the level of aggregation not relevant, they were allowed not to vote, i.e. abstention was permitted. (see for example Figure B-1).

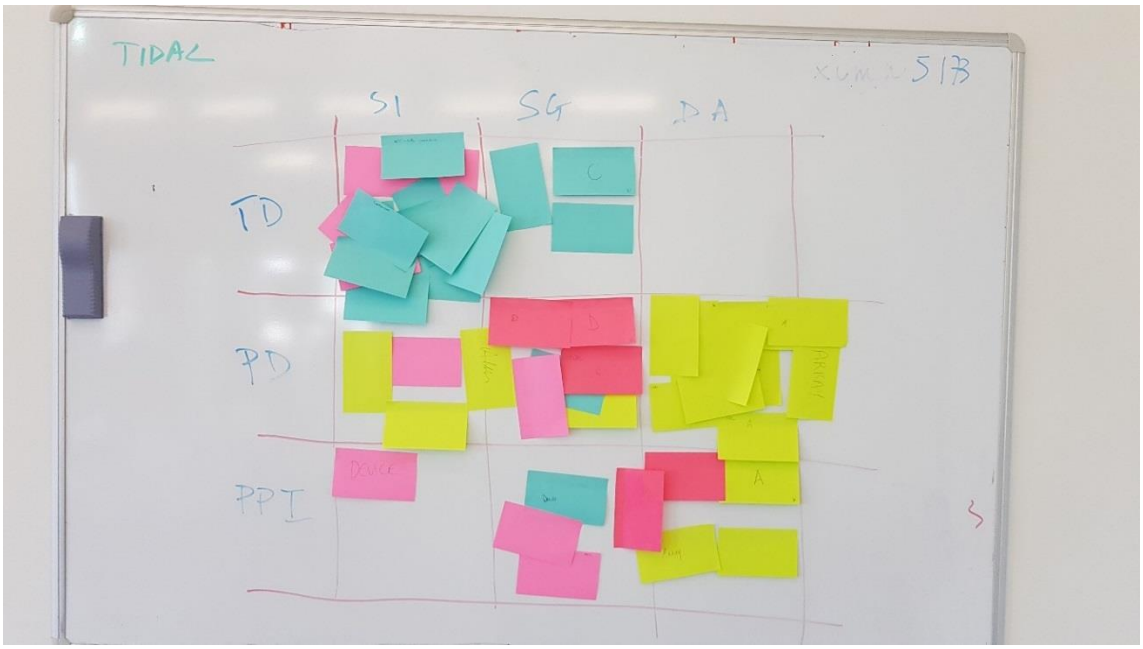

FIGURE B-1. EXAMPLE OF POLL (TIDAL TECHNOLOGIES).

ANNEX C. INTERNAL SURVEY DESCRIPTION

A survey was proposed to the partners in the consortium taking part into the activities of T2.3 of the project.

The survey consisted in filling a spreadsheet with two sections.

Section 1 consisted in filling a "Matrix for identification of priorities". The users were asked to fill the matrix in Figure C-1, selecting the three most interesting Validation Scenarios, according to their needs.

		Tools to be Tested		
		Structured Innovation Tools	Stage Gate Tools	Deployment Design Tools
Level of Complexity	Array Level			
	Device Level			
	Sub-system / Component Level			

FIGURE C-1. THE "IDENTIFICATION OF PRIORITIES" MATRIX

In the matrix in in Figure C-1, the rows represent the level of aggregation the user would like to investigate in the most favourite scenario:

- Array
- Device
- Subsystem.

The columns of the matrix represent the tools the user would like to test:

- Structured Innovation Tools: generally, but not exclusively, at early stages of design;
- Stage Gate Tools: generally, but not exclusively, at mid-stage of design;
- Deployment Design Tools: generally, but not exclusively, at late stage of design.

In order to identify the priorities, users were asked to annotate the cells in the spreadsheet with numbers from one to three, with one referring to the most interesting scenario and three to the third most important scenario. The users (as Nova Innovation did) could select less than three scenarios but they were not allowed to select more than three.

Once the Priority Matrix was completed, three spreadsheets sheets were automatically generated and partially filled with the information from the Priority Matrix. The three spreadsheets, each briefly describing one of the three validation scenarios, all follow the template in Figure C-2.

#		A. SCENARIO CHARACTERISATION
A.1	**Tools to be Validated**	
A.2	**Technology Type**	
A.3	**Aggregation Level**	
A.4	**Example User Cases**	
A.5	**Brief Description of the Specific User Cases**	
		B. PROJECT DEFINITION
B.1	**User Name**	
B.2	**Total Power / Number of Devices**	
B.3	**Technology to be tested**	
B.4	**Intended Site**	
		C. DATA AVAILABILITY
C.1	**Technology Description**	
C.2	**Site Characterisation**	
C.3	**Catalogue of Components**	
C.4	**Catalogue of Services**	

FIGURE C-2. TEMPLATE OF THE VALIDATION SCENARIO DESCRIPTION SPREADSHEET

For each scenario, the spreadsheet covers three key areas.

- **A. Scenario Characterisation**. This section serves to identify the scenario and the scope and objectives to be achieved. It was asked to cover the following fields:
  - *A.1. Tools to be validated*. This field was completed automatically while filling the Identification of Priorities Matrix;
  - *A.2. Technology Type.* A dropdown menu allowed selection of tidal or wave technology;

- *A.3. Aggregation Level*. this field was completed automatically while filling the Identification of Priorities Matrix;
- *A.4. Example Use Cases*. This field was optional. A dropdown menu with Example Use Cases per kind of tools to be tested was generated automatically after filling the Identification of Priorities Matrix. The users were allowed to choose up to three Example Use Cases.
- *A.5. Brief Description of the Specific User Case*. This field was mandatory, and it was expected that the user would add a brief description of their main objectives while using the DTOceanPlus toolset.

- **B. Project Definition**. More details were asked about the project framework in which the toolset is supposed to run.
  - *B.1. User Name*. The company/institution who is filling the spreadsheet;
  - *B.2. Total Power/Number of Devices*. The total rated power or number of devices in the validation scenario;
  - *B.3. Technology to be tested*. This field required the name of the technology (if any) to be tested, as for example the device name or the component/subsystem
  - *B.4. Intended site*. This field required the location or intended site where to deploy the validation case.
- **C. Data Availability**. In this section, the users were required to provide information on how much data are available for the specific validation scenario.
  - *C.1. Technology description*. The user was required to select a value from Basic, Intermediate and Detailed according to how detailed the information -pertinent to technology- already available for this validation case is.
  - *C.2. Site Characterisation*. The user was required to select a value from Basic, Intermediate and Detailed according to how detailed the information -pertinent to the site- already available for this validation case is.
  - *C.3. Catalogue of components*. The user was required to select a value from Basic, Intermediate and Detailed according to how detailed the information -database of components- already available for this validation case
  - *C.4. Catalogue of Services*. The user was required to select a value from Basic, Intermediate and Detailed according to how detailed the information -pertinent to services (vessels, ports, infrastructures, O&M activities)- already available for this validation case

ANNEX D. INTERNAL SURVEY: ANSWERS FROM PARTNERS

NOVA INNOVATION

PRIORITY MATRIX

		Tools to be Tested		
		Structured Innovation Tools	Stage Gate Tools	Deployment Design Tools
Level of Complexity	Array Level			1
	Device Level			
	Sub-system / Component Level			

ORBITAL

PRIORITY MATRIX

		Tools to be Tested		
		Structured Innovation Tools	Stage Gate Tools	Deployment Design Tools
Level of Complexity	Array Level			1
	Device Level	3	2	
	Sub-system / Component Level			

IDOM

PRIORITY MATRIX

		Tools to be Tested		
		Structured Innovation Tools	Stage Gate Tools	Deployment Design Tools
Level of Complexity	Array Level			1
	Device Level		3	2
	Sub-system / Component Level			

CORPOWER

PRIORITY MATRIX

		Tools to be Tested		
		Structured Innovation Tools	Stage Gate Tools	Deployment Design Tools
Level of Complexity	Array Level			3
	Device Level	1		
	Sub-system / Component Level		2	

EDF

PRIORITY MATRIX

		Tools to be Tested		
		Structured Innovation Tools	Stage Gate Tools	Deployment Design Tools
Level of Complexity	Array Level			1
	Device Level		2	
	Sub-system / Component Level	3		

EGP

PRIORITY MATRIX

		Tools to be Tested		
		Structured Innovation Tools	Stage Gate Tools	Deployment Design Tools
Level of Complexity	Array Level			3
	Device Level	1		
	Sub-system / Component Level		2	

WES

PRIORITY MATRIX

		Tools to be Tested		
		Structured Innovation Tools	Stage Gate Tools	Deployment Design Tools
Level of Complexity	Array Level			3
	Device Level	1		
	Sub-system / Component Level		2	

ESC

PRIORITY MATRIX

		Tools to be Tested		
		Structured Innovation Tools	Stage Gate Tools	Deployment Design Tools
Level of Complexity	Array Level	3		
	Device Level	1		
	Sub-system / Component Level	2		

CONTACT DETAILS

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