READY DC

Deliverable 5.5

Report on second stakeholder event

WindEurope

May 2023

ABOUT READY4DC

The future electricity network envisioned by READY4DC will be characterized by a growing role of multi-terminal multi-vendor (MTMV) HVDC solutions within the current AC transmission networks both onshore and offshore. READY4DC is contributing to this synergistic process by enabling commonly agreed definitions of interoperable modelling tools, model sharing platforms, clear processes for ensuring interoperability, and an appropriate legal and political framework.

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Deliverable 5.5
Report on second stakeholder engagement event

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READY4DC

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1. CONTEXT

On 3 May 2023 the READY4DC project consortium organised the second dissemination event of the project. It was held online to maximise the participation of stakeholders.

The objective of the event was to present the ongoing activities of the project to a wide audience of relevant stakeholders and to create awareness about the work performed in each Working Group (WG) within the project. Furthermore, the event aimed to steer the discussion on the challenges of an interoperable, multi-vendor HVDC system and to facilitate the creation of a community of experts that will develop recommendations for an interoperable and expandable Direct Current (DC) grid in Europe.

The specific objectives of the event were to:

- Update participants on the progress achieved by each WG;
- Engage experts from various sectors e.g. High Voltage Direct Current (HVDC) technology manufacturers, Transmission System Operators, the wind energy industry, policymakers, system integrators, other relevant technology providers and academia further in the discussion on interoperability, DC technology and the future of the European grid; and
- Present the preliminary findings of the four whitepapers published by the project Working Groups (WGs).

This report on the second stakeholder engagement event is the deliverable D5.5 described in Work Package 5, Task 5.2. It summarises the discussion that took place during the event, to comment on the engagement of relevant stakeholders, to reflect comments and questions posed by the audience and to recommend how the outcomes of the discussion can be used by the READY4DC consortium and its WGs.

1.1 AGENDA OF THE EVENT

READY4DC - 2nd Stakeholder Engagement event	
14:00 – 14:05	**Introduction** • Antonello Monti, RWTH Aachen
14:05 – 14:15	**Opening** • Eric Lecomte, DG Energy, European Commission
14:15 – 14:25	**Overview of the READY4DC project** • Ilka Jahn, RWTH Aachen
14:25 – 14:45	**WP1: Modelling, simulation framework and data sharing for multi-vendor HVDC interaction studies and large-scale EMT simulation** • William Leon Garcia, SuperGrid Institute
14:45 – 15 :05	**WP2: Legal Framework for the Realization of a Multi-vendor HVDC Network** • Vincent Lakerink, University of Groningen
15:05 – 15:15	**Coffee Break**

15:15 – 15:35	**WP3: Multi-vendor Interoperability Process and Demonstration Definition** • Nico Klötzl, TenneT
15:35 – 15:55	**WP4: Framing the future European Energy System** • Ilka Jahn, RWTH Aachen
15:55 – 16:00	**General Q&A and closing** • Antonello Monti, RWTH Aachen

1.2 STAKEHOLDERS PARTICIPATION

The second stakeholder engagement event took place online and was open for participation to all interested stakeholders. WindEurope and other consortium partners communicated about the event on social media and announced it on the project's website, social media accounts and their networks of experts.

To be able to participate, interested stakeholders had to subscribe to the project's dissemination list which currently counts for 426 experts. This list includes experts that represent the transmission system operator (TSO) industry, High Voltage Direct Current (HVDC) and other grid technology suppliers, wind turbine manufacturers and wind farm developers and operators, policymakers, academia, consultants from the EU, the UK, the United States, Canada and other regions globally. Additionally, to this list of experts, all the experts currently participating in the READY4DC WGs and all partners of the InterOPERA EU project were invited.

In total 76 participants joined the online event with a very active engagement throughout its duration.

The presentations shared during the event and the recording of the event have been uploaded in the project's website and are publicly available here.

Figure 1 Screenshot from Teams platform before the start of the event

2. SUMMARY OF THE DISCUSSION

Professor Antonello Monti (RTWH Aachen) opened the event. He welcomed participants and reminded the audience that READY4DC is a Coordination and Support Action project, which focuses on tackling the challenges of multi-terminal multi-vendor (MTMV) HVDC systems through creating a community of experts and publishing a series of white papers.

Professor Monti told the audience that the first whitepapers have been released. He encouraged participants to provide feedback on the direction of the project and to the work of the WGs.

He outlined the agenda of the event and introduced Mr. Eric Lecomte from the European Commission to set the scene for the event.

2.1 PRESENTATION BY THE EUROPEAN COMMISION

Mr. Eric Lecomte (European Commission) set the scene by presenting the strategic policy initiatives undertook by the European Commission in the last three years. First, the EU Offshore Renewable Energy Strategy set high ambitions of offshore wind and ocean energy by 2030 and 2050.

Second, following the Russian aggression to Ukraine, the European Commission presented the REPowerEU plan outlining short-term measures followed by long-term regulatory initiatives such as the recast Renewable Energy Directive.

Third, Mr. Lecomte mentioned The Green Deal Industrial Plan, presented in January 2023 by the European Commission to address long-term dependencies on raw materials and technologies that the energy transition to renewables could have. Notably, the European Commission presented the Net-Zero Industry Act in March 2023 proposing a framework to scale up manufacturing capacities of renewables and creating jobs in the EU. This Act aims to accelerate the permitting of manufacturing sites, incentivise financing, create a market for net-zero technologies through public procurement criteria on sustainability and resilience of their value chain, foster a skilled workforce, and facilitate innovation through regulatory sandboxes. Strategic net-zero technologies include solar energy, wind energy, batteries and storage, biogas, heat pumps, grid technology, electrolysers and fuel cells, and CCS.

Furthermore, Mr. Lecomte stressed that the Cluster 5 in the Horizon Europe research & innovation (R&I) programme is a key instrument supporting the development of HVDC grids. He presented all the projects funded this programme and its predecessors (the FP7 programme and Horizon2020). He referred to current and upcoming calls for superconducting technologies and stressed the role and their benefits in the R&I agenda.

Also Mr. Lecomte highlighted the role of the Strategic Energy Technology (SET) Plan in aligning national and EU R&I strategies and priorities. He stressed that the Implementation Working Group (IWG) on HVDC under the SET Plan is an important stakeholder to consider in the Ready4DC project, noting that it also covers other DC technologies. He also mentioned that it is proposed that the IWG renames to IWG on DC systems or DC grids, to include Medium Voltage (MV) and Low Voltage (LV) technologies too.

Last, Mr. Lecomte highlighted the InterOPERA project as successful outcome of READY4DC. He said that InterOPERA is one of the largest, most prominent flagship projects funded by the EU. And he wished the READY4DC partners success in the finalisation of the project.

2.2 READY4DC PROJECT OVERVIEW

Dr Ilka Jahn (RWTH Aachen University) presented the basic facts about the READY4DC project, highlighting that the work of READY4DC is indeed being incorporated by InterOPERA.

Dr Jahn stated that READY4DC intends to support all the preparatory phases that will lead to a demonstration project to de-risk the technology for the first MTMV HVDC system with grid forming capabilities in Europe. She reminded participants that READY4DC has a budget of €1 million and a duration of 18 months. Its partners include technology providers, transmission system operators (TSOs), and potential users of such novel MTMV HVDC systems.

The project scope is to facilitate agreement among stakeholders, through creating a platform for discussion. Topics being discussed in the Working Groups include compatibility of modelling tools towards interoperability, the legal framework for model sharing between TSOs, roles, financing and responsibilities etc.

Dr Jahn presented the measurable objectives of the project and the structure (concept) of the project, depicted below and available in the presentation slides on the website.

Figure 2 READY4DC measurable objectives

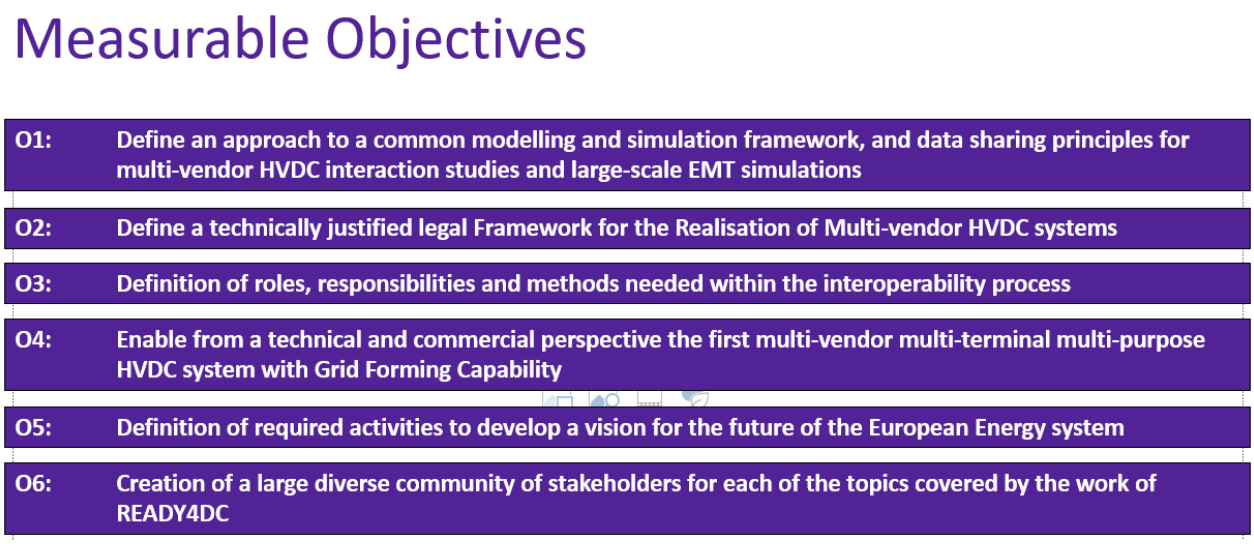
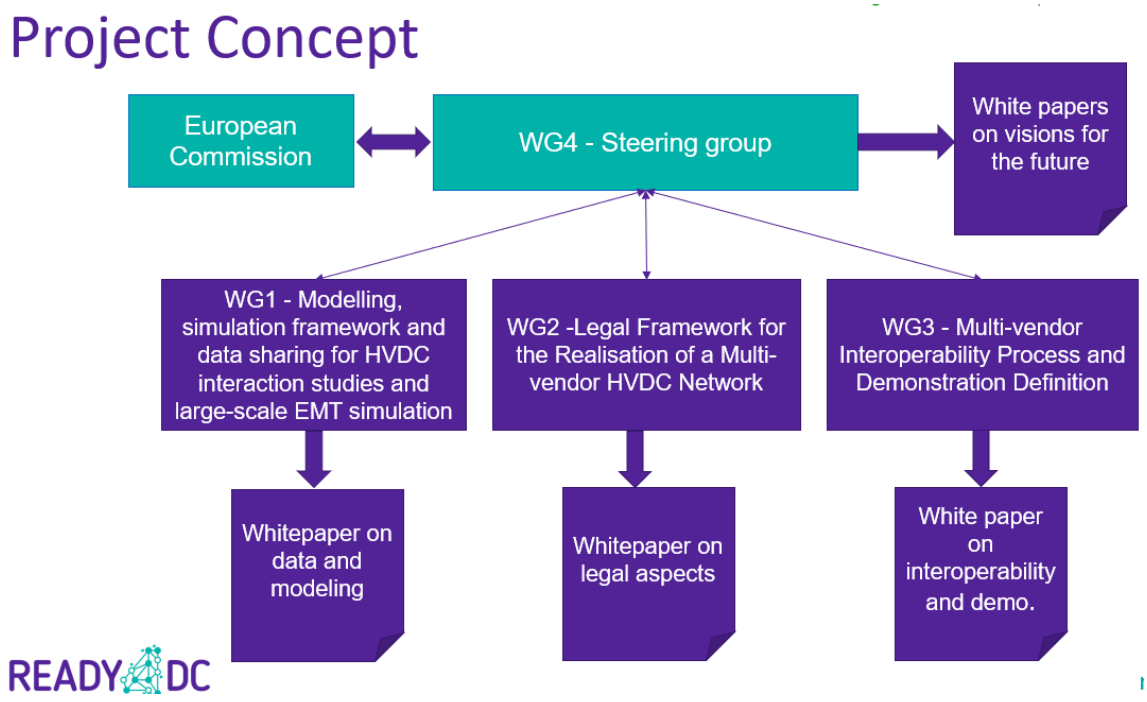


Figure 3 READY4DC project concept



She briefly described the specific activities of the four WGs and the decision-making process in the project. She encouraged participation from the event participants in the WGs, and through the communication channels of the project (e.g. LinkedIn, Twitter, etc).

She also said that the project has released the first version of the whitepapers for discussion with stakeholders before their final publication in autumn 2023. She also highlighted the work of other research initiatives on MTMV HVDC, including the work from CIGRE (workstreams B4.81 and B4.85), the IEC standard 63471 and the InterOPERA project.

2.3 WORKING GROUP 1: MODELLING, SIMULATION FRAMEWORK AND DATA SHARING FOR MULTI-TERMINAL MULTI-VENDOR HVDC INTERACTION STUDIES AND LARGE-SCALE EMT SIMULATION

William León García (Super Grid Institute) structured his presentation in five parts described below:

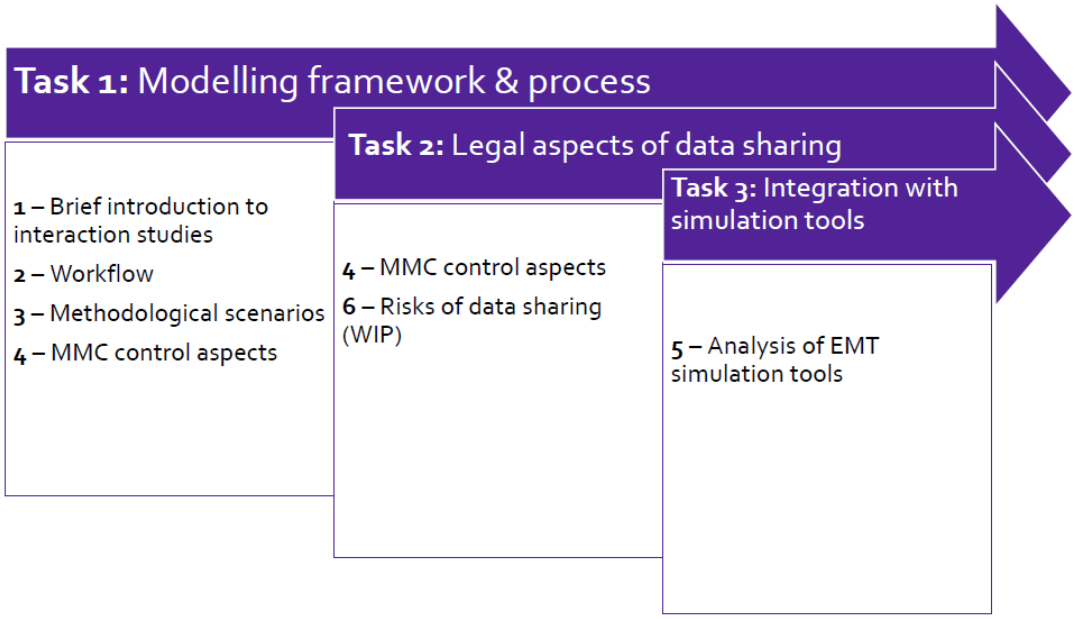
First, he provided an introduction comprising the context, motivation, and structure of the WG1 whitepaper. Mr. León García said that the EU ambition to develop a multi-terminal meshed grid on- and offshore in the future will lead to a system where components by different vendors will need to interact

on the alternate current (AC) and DC parts of such system. With the whitepaper, Working Group 1 (WG1) tried to provide answers to some important questions on these topics:

- What are the interaction studies considered necessary?
- Why are these studies needed?
- How these should be performed?
- When and who should make each study?

Then he explained the relationship between the three workstreams in the WG and the whitepaper structure. The whitepaper consists of six sections, depicted in the diagram below. He pointed out that the work on the last section (section 6) on the legal risks of data sharing is still in progress. And he invited participants to provide feedback.

Figure 4 WG1 Tasks and whitepaper structure



Second, he described the generalities of interaction studies in power systems, describing the state-of-art of the tools used to perform them. Based on the CIGRE document B4-81 on the 3 types of studies, and the phenomena each study addresses, WG1 identified additional possible phenomena and interactions arising from multi-vendor, multi-terminal systems. Mr. León García explained the complexity and uncertainty of such interactions. For example, under control loop interactions, WG1 identified possible steady-state phenomena and interactions related to the converter power headroom management and the DC voltage limits (refer to slides for details, available on the READY4DC website here).

Then he specified that the WG1 whitepaper will focus on Electromagnetic Transient (EMT)-time domain simulations because these are the most widely used for interaction studies. They allow to look at different kinds of interaction that can happen in a wide range of frequency domains, from phenomena happening in microseconds to minutes. But he stressed that there are other analytic approaches.

Mr. León García explained that the paper also outlines the workflow that interaction studies should follow. It is largely inspired by the approach of an EU code that suggests seven stages, and the T&D Europe's (European transmission and distribution trade association) latest paper on interaction studies that also suggests seven stages. The project compares these two approaches and deploys four different scenarios based on the roles that stakeholder could have in the process (vendors, integrator, TSO, HVDC owner and third-party experts). These scenarios led to discussions in the WG about when these interaction studies are relevant.

Third, Mr. León García explained a generic workflow for interaction studies, describing the methodology used, the roles of each player and the influence on controls accessibility. He went on describing that there are four stages in which these studies can happen. Today mostly happen after awarding contracts, when vendors are selected, and roles are well-known. However, studies can happen before this stage. If this is the case, there are elements to consider, Mr. León said. The paper therefore discusses what to do in each stage based on the roles of stakeholders. It uses four more scenarios in which the degree of responsibility that an *integrator* will have in the studies varies, in contrast to the original equipment manufacturer (OEM) vendor. The paper also discusses hypothetical scenarios varying the degree of Modular Multilevel Converters (MMC) controls.

Mr. León García then said that in multi-vendor projects there will be a need to exchange data, models and replicas while keeping intellectual property safe. Integrators will be making use of these models in order to prevent and to perform interaction studies. A point of discussion is to ensure that this flow of information is considered and not interrupted. Therefore, the paper also discusses the status on model and data exchanges in a MTMV system context.

Fourth, Mr. León García described the simulation tools available for interaction studies, also discussed in the paper. He explained that EMT simulations are widely used for interaction studies at all stages. And he described the approach to perform such simulations and the rationale for discussing them in the paper. He also explained the paper proposes four criteria to validate these simulation tools and it concludes that some standardisation could be achieved. He said the paper also compares the types of simulation tools using a variety of criteria. Mr. León García asked for feedback on the proposed comparisons and approach, noting that vendors have already given significant positive input.

Last, he stated the next steps, which are to i) integrate feedback from the InterOPERA project and its relevant Work Packages ii) focus on legal risks of data sharing, iii) expand technical aspects of model sharing, iv) prioritise interaction phenomena in the context of the MTMV system and v) summarise some of the contents and implement some minor changes of the whitepaper.

2.4 WORKING GROUP 2: LEGAL AND REGULATORY FRAMEWORK PRELIMINARY RESULTS

Vincent Lakerink (University of Groningen) presented the structure of the WG2 whitepaper, which focuses on three main issues: governance and roles and responsibilities; standardisation, intellectual property and competition law; and defining liability and risk allocation.

The paper is being developed in three phases: the status quo research and a gap analysis (done), the preliminary whitepaper that suggested solutions for the identified gaps (published), and the final whitepaper that will be ready in autumn 2023.

Dr. Philipp Ruffing (Amprion) talked about liabilities and risk allocation for MVMT HVDC systems**.** Those systems constitute a complex situation given the number of players and vendors. Defining liabilities and risk allocation is crucial to ensure accountability and to avoid disputes in cases of malfunctioning and interoperability issues. The whitepaper of WG2 looks into all these issues.

Today we have mostly point to point HVDC systems developed by turn-key projects. Responsibilities and roles are clear. But in the future, every converter system could be provided by multiple vendors, to different TSOs. This is quite different than today as the system responsibility shifts from the manufacturer to the TSO or system developer, increasing the design risk for the latter. A middle point is having several turn-key projects with less interfaces, which would decrease the risks and liabilities.

Responsibilities therefore could change in the future. The whitepaper proposes three scenarios to try to identify such risks and liabilities. The work may not be fully completed by the end of READY4DC (September 2023) but other projects, such as InterOPERA may need to continue that work.

Next, Dr Ruffing explained the risks and liabilities in each project phase, as they are described below:

Project preparation

In the system design, responsibility for design shifts from vendor to TSOs or system developers. Based on that, the designer has to take certain responsibilities and therefore liabilities might change. Connecting turn-key systems can be an intermediate step in order not to change the allocation of risks and responsibilities very drastically.

In procurement, in the scenario of a MTMV system the situation is different from what we have today. Delays in completing a subsystem, for example a converter station, could impact the overall integration and interoperability test. Therefore, reliable methods are important in order to determine responsibility for malfunction in the overall system. Requirements in contracts may not cover all issues and uncertainties based on this approach.

Project execution

In engineering, TSOs or system developers will bear the risks of new testing and interface challenges. Questions arise on the liability this stage. Interfaces become more complex. Delays and additional efforts that could affect the schedules of other subsystems from different manufacturers have to be taken into consideration.

In commissioning, the problems are very similar. In the turn-key world, one vendor is responsible for the commissioning, but in the case of distributed multi-vendor systems the TSO or developer of the system bears these responsibilities. A suggestion to mitigate and reduce interdependency risks would be to start with a moderate increase of interface.

Operation

In operation, there might be also several risks related to interoperability and performance of different modules. Defining and respecting responsibilities and liabilities of all parties involved is essential. During operation you might also have faults causing damages. Liability for such damages depends on procurement contract and roles and responsibilities of parties involved. A clear procedure and an investigation that includes a review of all phases (design, installation, commissioning, etc) are important to be able to identify the root cause of fault and thus, allocate the costs.

Maintenance

Maintenance is not as critical as other stages, but still the challenge to identify the root cause of fault and to allocate liability in multi-vendor systems remains. In order to mitigate the risk, we need clear maintenance contracts with defined roles and responsibilities for each vendor and provisions for fault analysis and liability allocation.

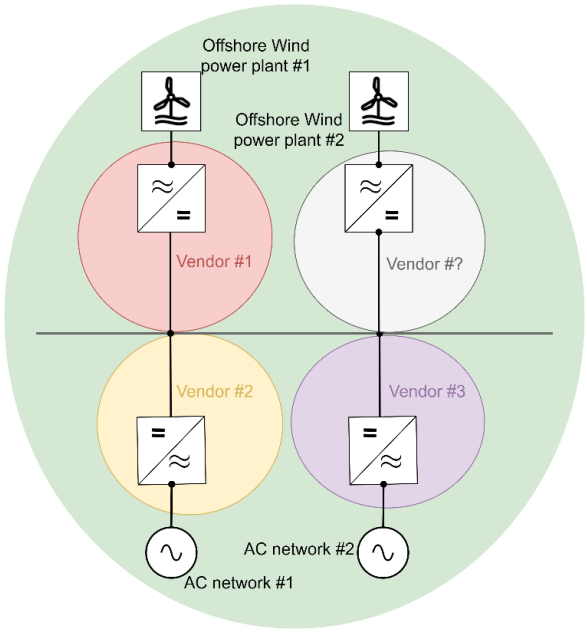
Regarding the end of lifetime, WP2 did not identify additional risks causing a shift of liabilities regarding refurbishment or decommissioning, but Dr Ruffing invited participants to provide any feedback on this topic.

Finally, Dr Ruffing explained that the whitepaper identified three scenarios on the impact of MTMV HVDC systems on liabilities and risk allocation. READY4DC provides input for InterOPERA, which will design a procurement strategy, templates for contacts and specifications. In the future, the first grid projects will provide the lessons we need, but Dr Ruffing stressed the importance of a proper information exchange platform between TSOs to avoid duplication of mistakes.

2.5 WORKING GROUP 3: MULTI-VENDOR INTEROPERABILITY PROCESS AND DEMONSTRATION DEFINITION

Mr Nico Klötzl (TenneT) presented as an introduction a pictogram (see below) of what is generally understood under MTMV systems.

Figure 5 A MTMV HVDC system



He explained the objective of WG3 as to provide the guidelines for the demonstration project. This includes the selection criteria and the proposal of up to three potential candidate projects. It also covers the procedure for selecting functional specifications. In the last five months of the project, WG3 is discussing the key milestones to achieve the realisation of the demonstrator and a roadmap for future beyond demonstration projects.

Mr Klötzl presented the early findings of the WG3 whitepaper that describes the selection criteria for the first MTMV demonstrator. These are divided in soft criteria and functional specifications based on DC grid needs. First, it outlines must-have and optional soft criteria that will be considered for the demonstrator. The five must-have soft criteria are the following: multi-terminal, multi-vendor, expandable and with the possibility for reconfigure parameters. The two optional soft criteria defined are multi-purpose and multiple TSOs. On functional specifications, the paper proposes that they are described as functional requirements and gives indications how possible design impacts of the demonstrator could influence these requirements. For example, a functional requirement is “compliance to system operation guideline (SOGL)” and the design impacts are “DC fault protection, or DC control, etc.” Other functional requirements would include fulfilment of transmission requests, etc.

Mr Klötzl encouraged stakeholders to provide feedback on these early findings.

Moving forward to the early findings regarding the selection of potential candidate projects, WG3 identified only three projects so far: Bornholm Energy Island, North Sea Energy Island, and a generic MTMV system hub.

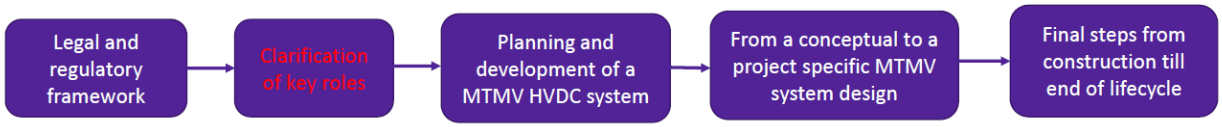
On the procedure for selecting functional specifications, the whitepaper suggests a stepwise and iterative approach, as shown in a simplified way in the figure below. In red it is the step that is considered important for all relevant stakeholders to align on during this process.

Figure 6 Procedure for selecting functional specifications

First, information on planned multi-terminal and possible multi-vendor projects in Europe is collected. If the basic requirements were fulfilled, then these projects can be used to generate most probable types of projects. Out of these projects, mandatory and non-mandatory specifications for MTMV could be developed. Then it should be checked whether the specifications are part of the available standards and if not, they may be tested in offline/real-time simulations. In the last step, if practicability is proved, it is added to the standardisation process.

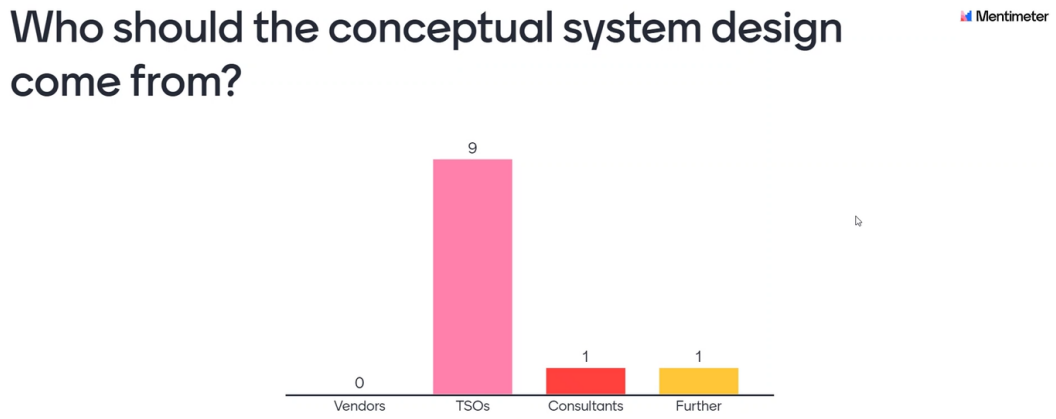
Mr Klötzl also provided an outlook of the upcoming task to define key milestones in implementing a first MTMV demonstrator, as shown in the figure below. In red it is the step that highlights the need for alignment across the stakeholders during this process.

Figure 7 Key milestones in implementing a first MTMV demonstrator



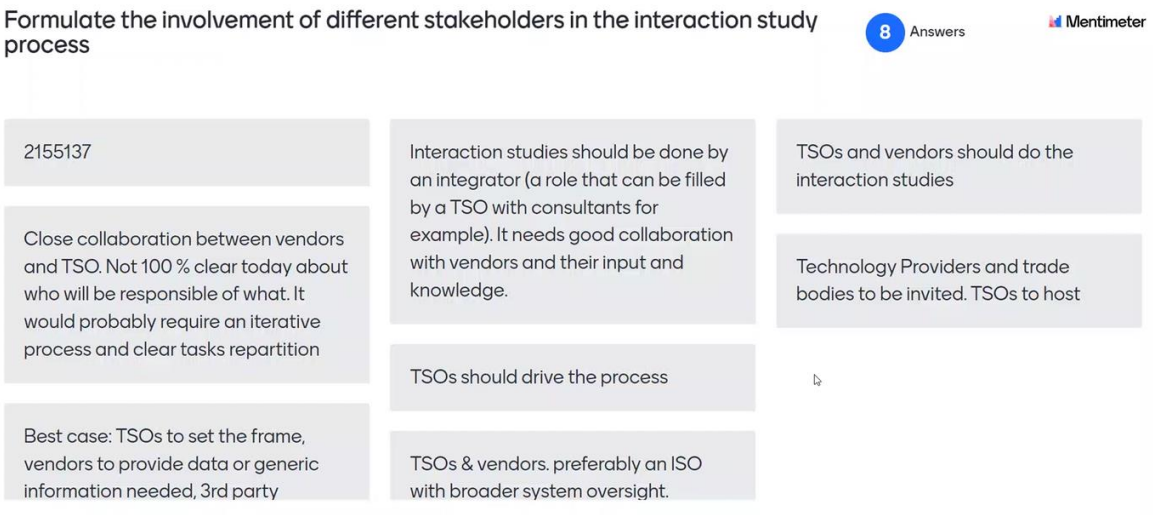
Mr Klötzl launched a quick online live survey on the clarification of key roles and responsibilities. The question asked was the following: “Who should the conceptual system design come from?”. Also, he asked to the TSO audience if they felt were capable to perform this conceptual system design and if they count with the tools to do perform it.

Figure 8 Screenshot from online survey (1)



The second question on interaction studies was about the involvement of different stakeholders in the interaction studies process.

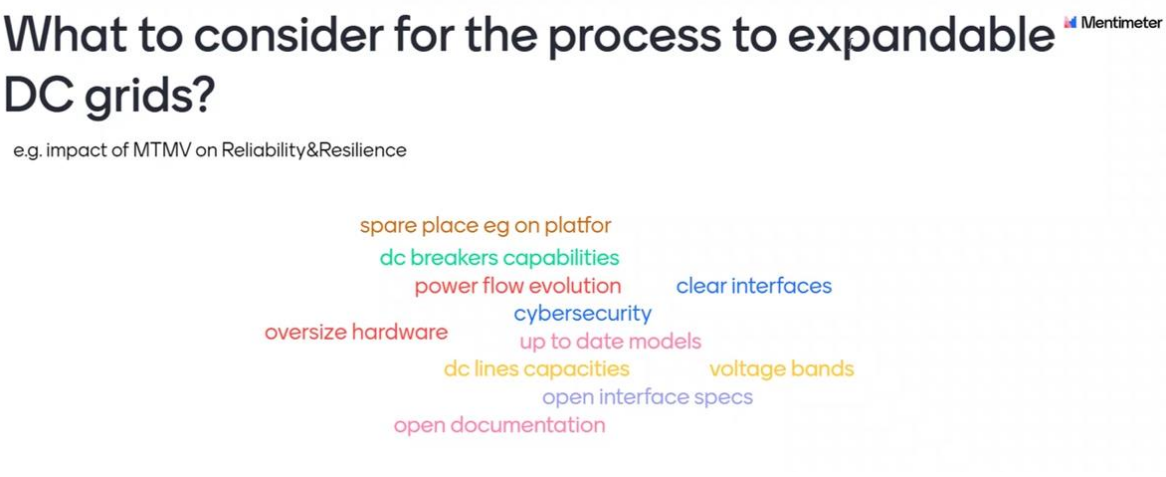
Figure 9 Screenshot from online survey (2)



Mr Klötzl presented the roadmap for future expansion beyond the demonstration projects. There are five elements to be considered: the process for expandability towards largescale multi-vendor HVDC grids, for example how this could affect reliability and resilience; reviewing and formulating potential planning standards and roles of key actors; formulating recommendations to the regulatory bodies; developments or amendments to network codes and operation guidelines; discussing possibilities to other DC multi-vendor applications on medium voltage.

Mr Klötzl launched another online survey and asked feedback about what else should be considered for the process to expandable DC grids.

Figure 10 Screenshot from online survey (3)



Finally, Mr Klötzl presented the timeline with the next steps for the whitepaper. The final version should be ready by the end of September 2023.

2.6 WORKING GROUP 4: FRAMING THE FUTURE EUROPEAN ENERGY SYSTEM

Dr Ilka Jahn (RWTH Aachen University) presented the structure of WG4; WG4 extracts information from the other WGs to shape a vision for the future HVDC system in Europe and provides a framework for the exploitation of the project outcomes. Based on the output of the other WGs, WP4 addresses two main topics. The first one is about how to unlock investments (published). The second is about Framing the European Energy System.

Dr. Jahn presented the statistics of participation in WG4. By the time of the event, it has 49 people with meeting attendance between 6 and 21. Main countries represented are Germany, United Kingdom, Denmark, the Netherlands.

On the first whitepaper on unlocking investments, five topics are covered:

- investment options;
- investment volume and sustainability of supply;
- blocks for investing into the first MTMV HVDC demonstrator;
- financial decision-maker experience; and
- plan to unlock investments.

When it comes to investment options, the paper highlights the complexities around regulation, revenue streams, new parties joining the offshore market, ownership, cost sharing, etc. Dr Jahn thanked the WG4 members for all their contributions to the paper.

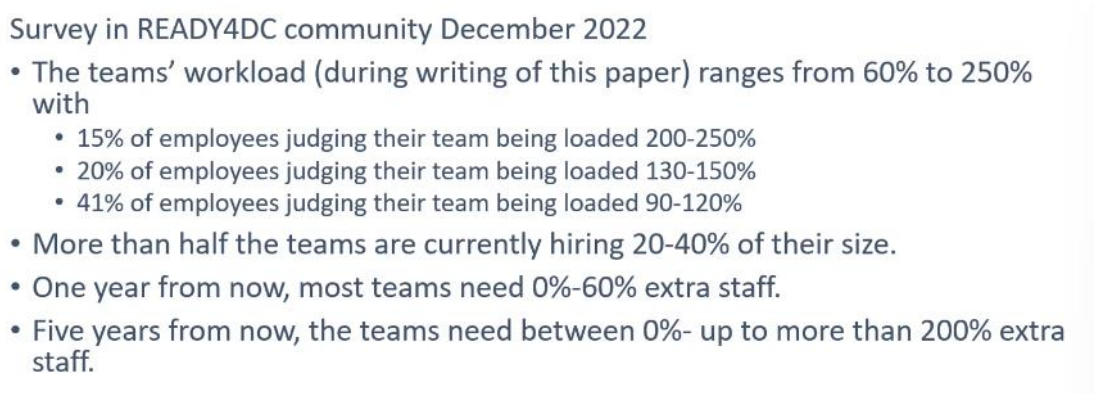
She explained that the size of initial first-of-a-kind projects may be high and outside national or international support schemes. Dr Jahn gave a specific example of a DC circuit breaker bypass, a case study from the PROMOTioN project – the only publicly available cost-benefit analysis. And while this is not fully representative, it provides an idea of the magnitude of the investments. The case study was a simple project, onshore, connecting two single vendor pole-to-pole HVDC links. The costs were estimated from €17 to 38 million. This was a single piece of equipment. Despite the positive cost benefit ratio, the risk was considered too high.

Dr Jahn explained that the most likely funding source for first-of-a-kind projects would be the EU funding Connecting Europe Facility/ Projects of Common Interest, but there are still open questions around anticipatory investments. WP4 discussed about the possibility of "first-of-a-kind Europe" for technology with strategic importance and that could consider technology integration aspects that can be different outside Europe, also with regards to intellectual property. Public-private partnership could be a good option for financing and sharing risk.

The WP4 first whitepaper also performs a back-of-envelope estimation of the investment needs. Dr Jahn described the process followed and the assumptions the authors made to arrive at the €520 billion needed. She clarified that grids would need €20 billion per year until 2050. This raises questions about costs to TSOs against their revenues. The paper suggests that public-private partnerships and private initiatives could play a role in such an endeavour.

In December 2022, READY4DC WG4 surveyed the workload needed to carry out such projects based on the effort used in the WG. The results are depicted below.

Figure 11 Results of the survey in READY4DC community



WG4 also performed an analysis of blocks for investing in the first demonstrator. It showed that organisational aspects are the major constraint (national vs. cross-border project specificities, unclear agreements, fair technical competition, etc.). followed by economic aspects (risk compensation for first mover, risk premium, etc.). Surprisingly, technical barriers were not that significant.

Dr Jahn explained that WG4 also interviewed financial decision-makers. For investors, having visibility on regulation is the key. There is an appetite for unproven technology as long as there is a long-term perspective as well. TSOs raised that more political support is crucial and urgently needed for investments in new technology; anticipatory investments should be possible. And wind developers stressed the need for a clear definition of ownership, governance, operation, cost-sharing etc. and raised the issue of different objectives between developers and TSOs (revenue vs security of supply).

Finally, the whitepaper provides some suggestions to unlock investments. First, de-risking is needed. This can be done for example, by using multi-vendor hardware-in-the-loop testing. Also, anticipatory investments should be allowed. Finally, Dr Jahn stressed the important role of political support in boosting development, as in the case of Denmark.

Dr Jahn also explained that the InterOPERA project provided feedback to WP4. From the questions raised, she clarified that procurement is out of the scope of READY4DC.

She encouraged participation in the WG4 and informed that the next two steps of WP4 are the whitepaper on the long-term view for HVDC technology and on framing the European energy system (role of DC and barriers).

2.7 CLOSING REMARKS

Prof Monti reminded participants that the READY4DC community is open to feedback and participation for all interested stakeholders. Finally, he thanked all speakers and participants for joining the second READY4DC stakeholder engagement event.

3. CONCLUSIONS

The participants in the second dissemination event of the READY4DC project engaged in a very interesting and helpful discussion before the final steps of the project. During the event, participants submitted their questions to the chat and speakers provided direct answers and ensure to take into consideration feedback provided.

READY4DC WGs continue the work towards the final versions of the whitepapers over the next five months, until the end of the project (September 2023).