WP 1 Modelling, Simulation framework and data sharing for multi-vendor HVDC interaction studies and large scale EMT simulation

First Dissemination event presentation

READY DC

FILLIOT Louis, SuperGrid Institute

13 July 2022

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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PROJECT DETAILS:

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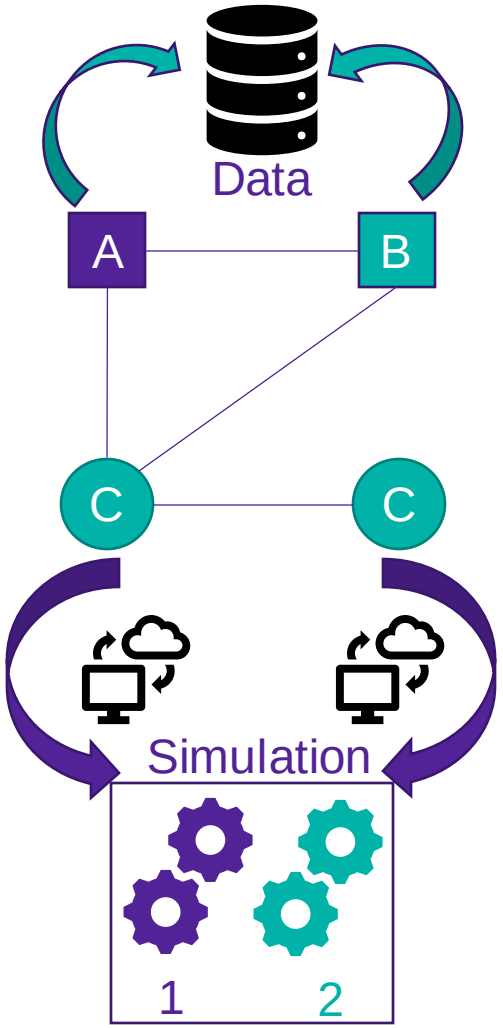
Agenda

- 1. General information on WP 1
  - Objectives, global planning
  - Organisation, members
- 2. Whitepaper structure and content
  - Scope of the WP: description of main issues and tasks
- 3. Topic example: Methodology for compliant model exchange and integration

1

General information on WP1

WP 1 General Description



- **<u>Need :</u> Validate in simulation a multi-vendor multi-terminal HVDC project at each stage of the project**
- To perform those studies, several models from different stakeholders must be integrated and different simulation tools will be used :
  - involves sharing models and data between different entities.
  - without disclosing any content that has IP value, is sensitive or confidential.

<u>Objectives :</u>

→ Identify all issues and challenges to perform such modelling & simulation studies

→ Analyze some possible solutions to overcome those issues.

→ A modelling and simulation framework must be proposed, analysing technical barriers as well as legal and methodological aspects.

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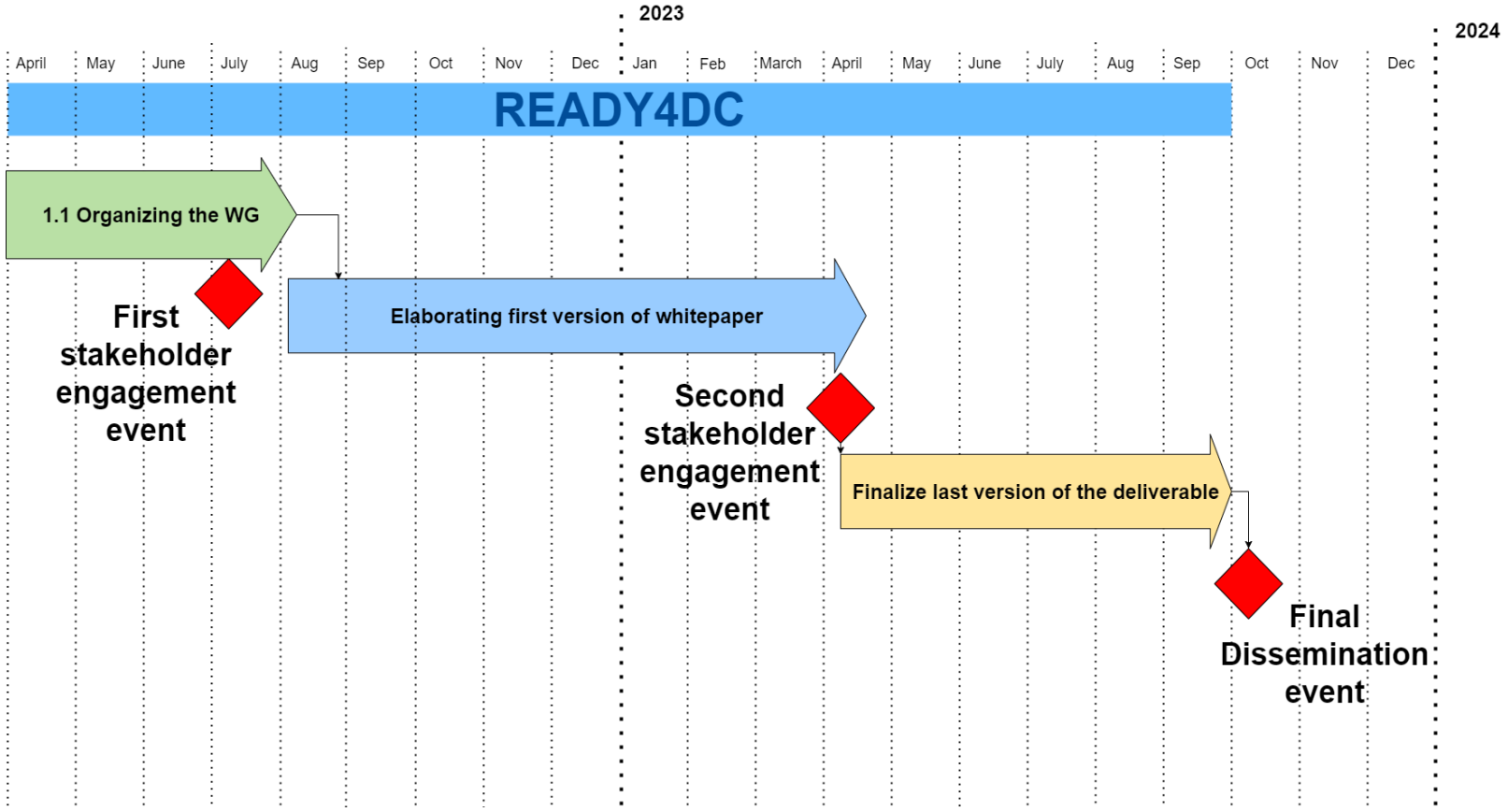
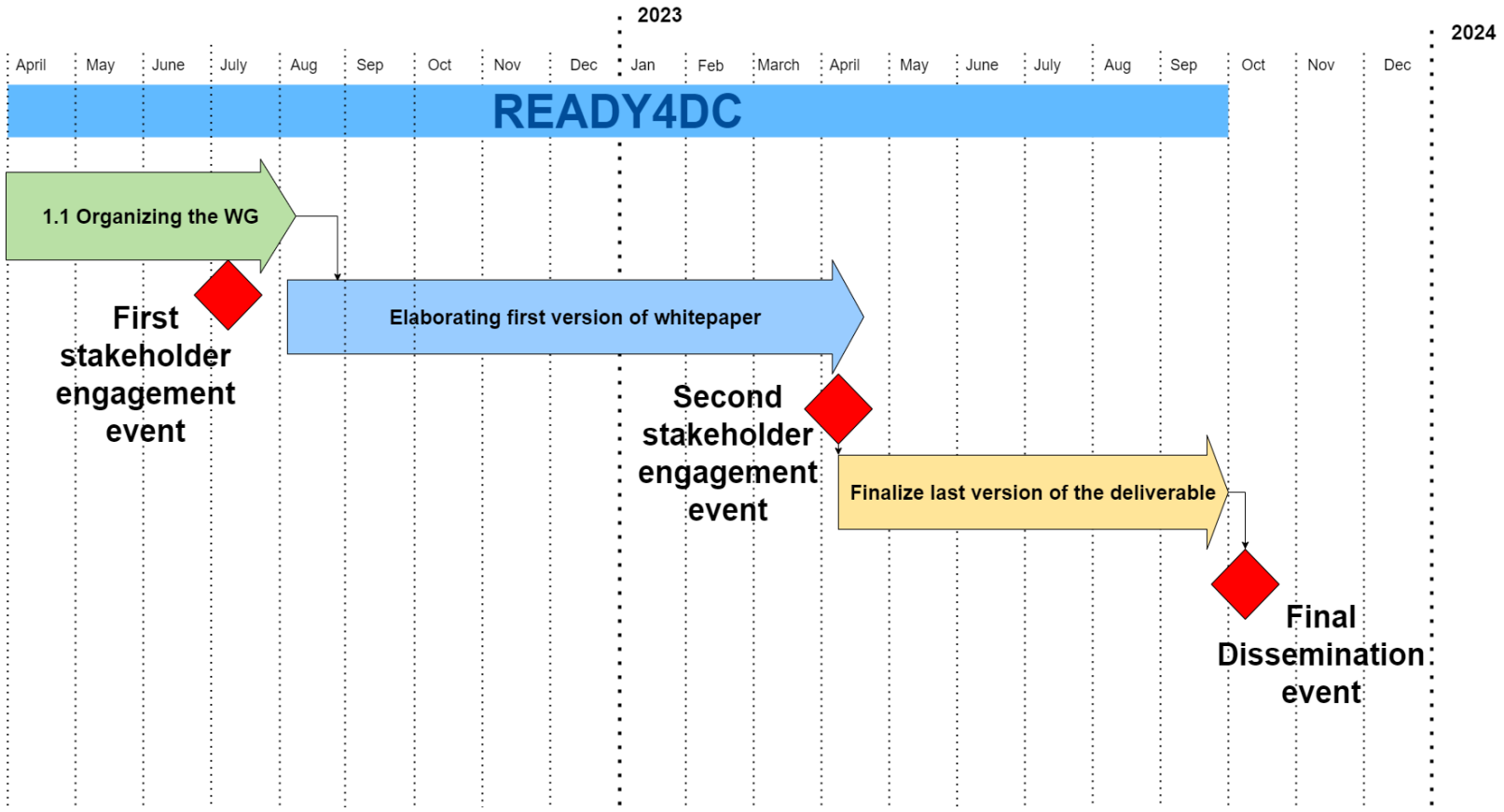
Objective and planning



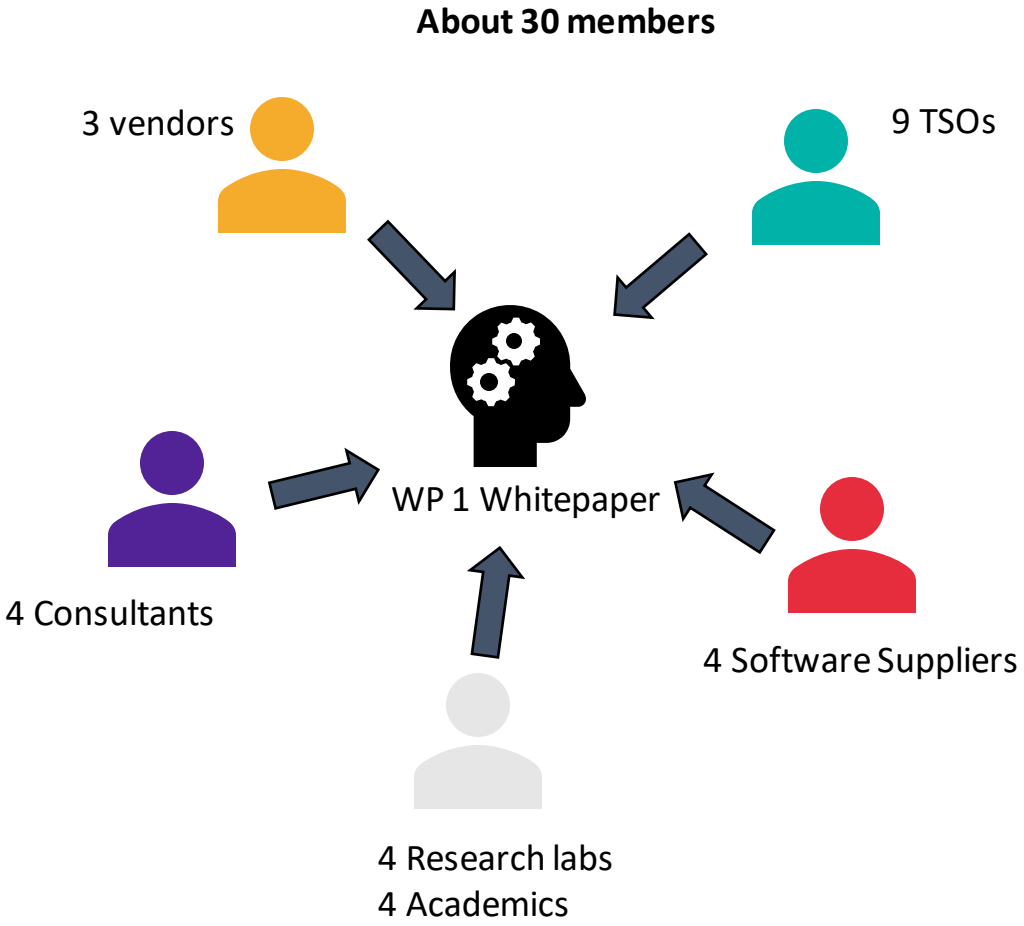
- Produce a whitepaper as major deliverable offering technical advice on modelling approaches and data exchange
- No choice/decision, but state-of-the art + listing ideas solutions, pros and cons analysis

Objective and planning



- Done May/June :
  - Gather the members, co-chairs
  - Practical organisation
  - Agree on whitepaper skeleton, key definitions, issues to tackle
- From now on:
  - Progress on the whitepaper for each issue/subject

Organisation, members



- All stakeholders gather in and provide their views on main challenges and solutions to be explored:
  - the vendors providing component or control models (for converters, wind farms or various DC equipment),
  - the simulation software suppliers developing the simulation tools
  - Simulation software users who might perform studies integrating the vendor models:
    - TSOs
    - Research/integration labs
    - Consulting companies
- Co-chairs :
  - Sébastien Dennetière : RTE
  - Dimitar Kolichev : T&D Europe
- Meetings :
  - Every two weeks : general meetings or smaller groups workshops

2

Whitepaper structure and content

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Whitepaper Structure : Modelling framework & process

Need

Validate in simulation a multi-vendor multi-terminal HVDC project at each stage of the project

Issues

1. Which studies should be performed ?

- Which models precision required for each stage of the project ?
- Which type of studies for each stage : phenomena, simulation scenario (faults, short circuits, AC side, DC side…) ?
- Which simulation tools (phasor/EMT/real-time/HIL…) ? Which computation times ?

Whitepaper Structure : Modelling framework & process

Need

Validate in simulation a multi-vendor multi-terminal HVDC project at each stage of the project

Issues

1. Which studies should be performed ?

2. Which methodology/organisation to perform multi-vendor studies ?

- Who is delivering what, with which requirements ?
- Who performs each step of the interaction studies ?
- How to proceed in case of interoperability issue, disagreement ?

Whitepaper Structure : Modelling framework & process

Need

Validate in simulation a multi-vendor multi-terminal HVDC project at each stage of the project

Issues

1. Which studies should be performed ?

2. Which methodology/organisation to perform multi-vendor studies ?

3. How do we maintain models for the entire lifecyle ?

- How to have an easy to maintain model ?
- How to version different release of the model ?
- How to make sure vendors keep maintaining models ?
- How to specify models that guarantee software, compiler and version compatibility over 25 years ?

Whitepaper Structure : Modelling framework & process

Need

Validate in simulation a multi-vendor multi-terminal HVDC project at each stage of the project

Issues

1. Which studies should be performed ?

2. Which methodology/organisation to perform multi-vendor studies ?

3. How do we maintain models for the entire lifecyle ?

Task 1 : Modelling framework & process

Whitepaper Structure : legal aspects of data sharing

Initial Issues

1. Which studies should be performed ?

2. Which methodology/organisation to perform multi-vendor studies ?

3. How do we maintain models for the entire lifecyle ?

Vendor model will be shared to another entity (TSO / 3rd party or other vendor)

Resulting issue

4. How to prevent possible reverse-engineering ?

- What are the technical solutions to protect vendor control model IP (even if black boxed) ?
- What are the legal protection possible ? Is this compliant with WP2 ?
- How to interface model without disclosing IP ?

Whitepaper Structure : legal aspects of data sharing

Initial Issues

1. Which studies should be performed ?

3. How do we maintain models for the entire lifecyle ?

2. Which methodology/organisation to perform multi-vendor studies ?

Vendor model will be shared to another entity (TSO / 3rd party or other vendor)

TSOs may need to exchange data about their networks

Resulting issue

4. How to prevent possible reverse-engineering ?

5. Which TSO data are considered sensitive and how to protect them ?

- What is the current EU regulation and what is missing ?

Whitepaper Structure : legal aspects of data sharing

Initial Issues

1. Which studies should be performed ?

2. Which methodology/organisation to perform multi-vendor studies ?

3. How do we maintain models for the entire lifecyle ?

4. How to prevent possible reverse-engineering ?

5. Which TSO data are considered sensitive and how to protect them ?

Task 2 : Legal aspects of data sharing

Whitepaper Structure : Integration with Simulation tools

Initial Issues

1. Which studies should be performed ?

3. How do we maintain models for the entire lifecyle ?

2. Which methodology/organisation to perform multi-vendor studies ?

Validation with EMT and real-time software will be needed

Resulting issue

6. How to ensure compatibility of models into several software ?

Whitepaper Structure : Integration with Simulation tools

Initial Issues

1. Which studies should be performed ?

3. How do we maintain models for the entire lifecyle ?

Validation with EMT and real-time software will be needed

2. Which methodology/organisation to perform multi-vendor studies ?

Double validation by different integrators using different software may be needed

Resulting issue

6. How to ensure compatibility of models into several software ?

Whitepaper Structure : Integration with Simulation tools

Initial Issues

1. Which studies should be performed ?

3. How do we maintain models for the entire lifecyle ?

Validation with EMT and real-time software will be needed

2. Which methodology/organisation to perform multi-vendor studies ?

Double validation by different integrators using different software may be needed

An integrator lab may decide to switch of software in the future

Resulting issue

6. How to ensure compatibility of models into several software ?

- How to integrate a vendor model in several software ? One single format compatible with all platforms or several generation from the same initial model ?
- How to import/export simulation models between different software to accelerate studies ?

Whitepaper Structure : Integration with Simulation tools

Initial Issues

1. Which studies should be performed ?

3. How do we maintain models for the entire lifecyle ?

2. Which methodology/organisation to perform multi-vendor studies ?

Large-scale EMT simulations are required

Resulting issue

7. How to enable large scale EMT simulation?

- Which difficulties do we have to achieve desired level of accuracy and speed of computation ?
- How to improve the speed of computation ? Using new modelling / solver techniques

6. How to ensure compatibility of models into several software ?

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Whitepaper Structure : Integration with Simulation tools

Initial Issues

1. Which studies should be performed ?

3. How do we maintain models for the entire lifecyle ?

2. Which methodology/organisation to perform multi-vendor studies ?

Resulting issue

7. How to enable large scale EMT simulation?

6. How to ensure compatibility of models into several software ?

Task 3 : Integration with simulation tools

3

Topic example : Methodology for compliant model exchange and integration

Which methodology/organisation to perform multi-vendor studies ?

- What are the different roles during the multi-vendors interaction studies ?
  - Animation/Coordination of the model exchanges
  - Simulation : performing the interaction studies
  - Interoperability issue troubleshooting
  - Mediation in case of disagreement
  - Proposing solution to interoperability issue (control update/tuning…)
  - Update or Tune a control

Which methodology/organisation to perform multi-vendor studies ?

- Who endorses which role ?
  - Role of vendors ?
  - Role of “HVDC System owner” : TSO(s), third party ?
- Description of the different methodological options
  - Example given by T&D Europe article
- Pros and cons analysis for each option

→ Join next meeting to take part in the discussion !

Thank you !
Any Question ?

Contact louis.filliot@supergrid-institute.com to join WG 1 or for any question

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READY4DC WG 2 Legal Framework

Vincent Lakerink & Ceciel Nieuwenhout:
Rijksuniversiteit Groningen

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1

Scope of Working Group 2

Scope of the working group

- Gather relevant stakeholders
- State of the art of regulation and legislation and gap analysis
- guidelines for the creation of a legal framework of coordination and governance for multi-vendor projects
- White paper on the conclusions of working group 2

2

Standardisation

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Standardisation

- The definition of technical or quality requirements with which current or future products, production processes, services or methods may comply
  - Includes interoperability

- Art. 101 (1) TFEU (and the national equivalent of this article) prohibits, essentially: Coordination which has the object or effect of restricting competition.

Standardisation

- Standardisation is acceptable if:
  - Art. 101 (1) TFEU: it ultimately improves values of competition; or
  - Art. 101 (3) TFEU: Significant economic and/or technical efficiencies are reached, a sufficient part of those gains reach the consumer, whilst sufficient competition remains
- Difference in evidential burdens

- Vague terms, highly context dependent; relevant for agreements

Standardisation: Market share and coordination

- As the market share of coordinating companies in the relevant market increases, the scrutiny of said coordination increases

- The scrutiny can increase further, depending on the market structure:
  - barriers to entry (high capital requirements, processes highly protected by IP etc);
  - dominated by large companies;
  - transparency of the market;

Standardisation: risk factor

- reduction in price competition;
  - Increase in consumer price risky
- foreclosure of innovative technologies;
  - Complementary technology
    - essential due to lack of technical and/or economic substitutes
  - substitutive technology
    - not essential due to viable alternatives

Standardisation: risk factor

- exclusion or discrimination of other companies regarding the usage of a standard
  - No access to relevant IP related rights (the higher the compensation an IP rights holder demands for a license, the greater the risk
  - No access to the standard on fair, reasonable and non-discriminatory (FRAND) terms and conditions
  - No transparency into standard, the IP rights and the costs associated with licenses
  - large number of licenses from many parties
  - lack of countervailing buyer power
  - large market share

Further aims of WG 2 and standardization

- Determine market context from competition law perspective
- Further identify risk factors
- Apply market context to risk factors

3

IP law concerns

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Patents, trade secrets and know-how

- Patents:
  - Patentable, novelty, inventive,
    - Example: system level control for DC voltage
- Trade secrets:
  - secret, meaning not generally known or accessible to persons within the circle that normally deal with this information
  - Commercial value in its secrecy
  - subject to, given the circumstances, *reasonable steps*, by the person lawfully in control of the information, to keep it secret
  - example: Protection algorithms

- Know-how:
  - Knowledge related to technology that neither fits the definition of patent or trade secret.

Reasonable steps

- Commercial context
  - reasonability interpreted in light of usage of trade secrets and their value;
  - need-to-know for commercial exploitation influences reasonability.
- balance between restricting all communication and exploitation of trade secrets
  - confidentiality agreements vital in that balance

Interplay trade secrets and competition law

- Transparency:
  - Creation of standard, IP rights the standard contains, fees to be paid
- Access
  - Access to standard on FRAND terms
- Qualification of trade secrets
  - Loss of trade secret or violation of competition law
- Fees, licenses and compensation
  - Earning back investments (trade secrets)
  - Barrier to entry (competition law)

Further aims of WG2 and IP law

- Identify industry concerns surrounding IP associated with multi-terminal multivendor HVDC systems
  - Questionnaire
- Analyse concerns and legal risks

4

Guidelines on the Legal Framework of coordination and Governance

Guidelines on the Legal Framework of coordination and Governance

- Roles and responsibilities of the parties
  - Vendors, TSO's, generators etc.
- Liability
- Procurement

5

Work for the future

Work for the future

- Determine the industry view on IP associated with multi-terminal multivendor HVDC systems
  - questionnaire
- Analyse response and determine risks and issues
- Apply standardisation law and analyze risks and issues
- craft guidelines for, amongst other things, a governance board to further deal with liability and procurement issues.

Thank you

Interested? Contact me at: v.lakerink@rug.nl

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WP3 – Working Group (WG) on Multi-vendor Interoperability Process and Demonstration Definition (Lead:TenneT DE)

First dissemination event

READY DC

Wilhelm Winter (Chair) & Nico Klötzl, TenneT

13.07.2022

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WP3 Objectives

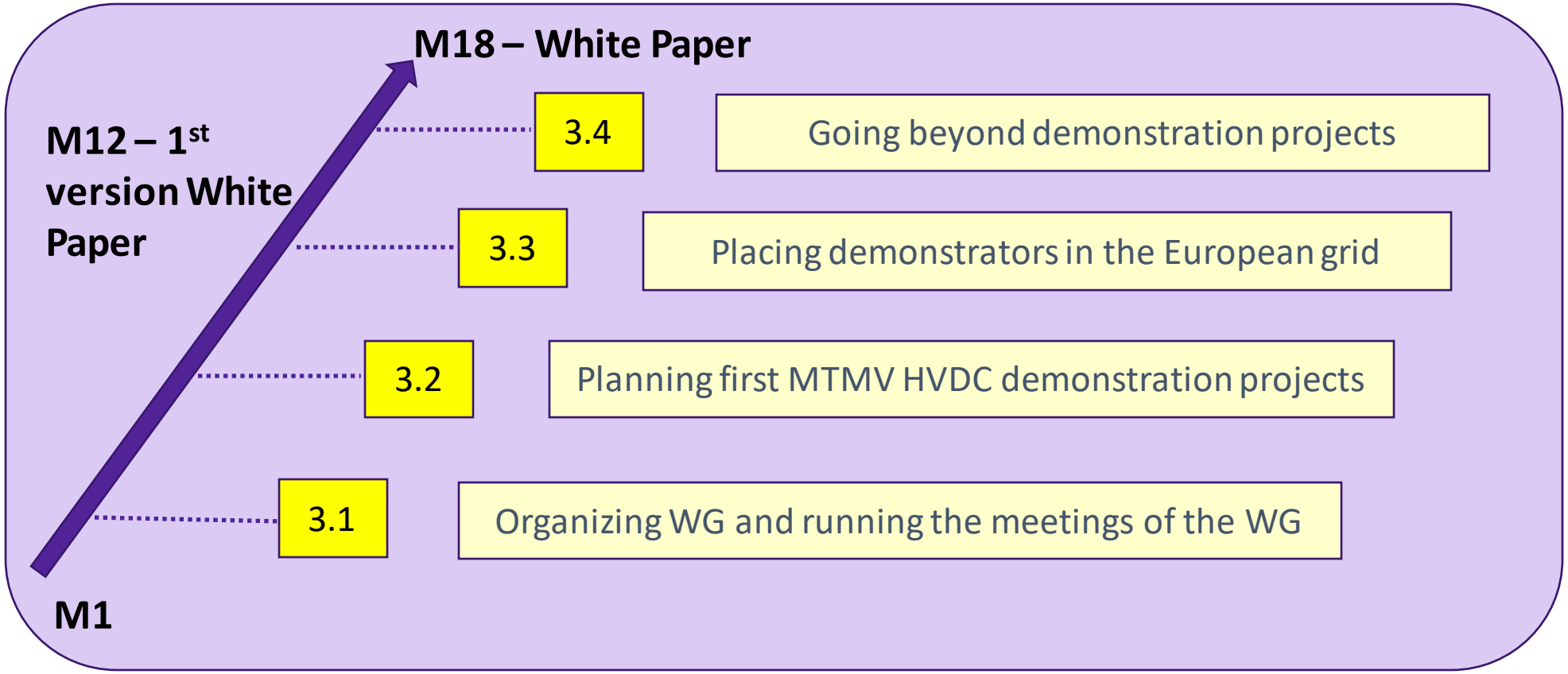
- Planning process for multi-terminal and multi-vendor HVDC demonstration projects
- Political, legal, regulatory framework (CNCs) and standards
- Guidelines for demonstration projects in the European transmission grid (TYNDP)
- Roadmap future expandability beyond demonstration projects

White Paper

- ✓ Path for agreement among various stakeholders (interoperability process for demonstrators)
- ✓ Define roles, responsibilities and recommendations for overcoming barriers
- ✓ Procedure for selecting functional specifications of MTMV HVDC projects

WP 3 split into tasks

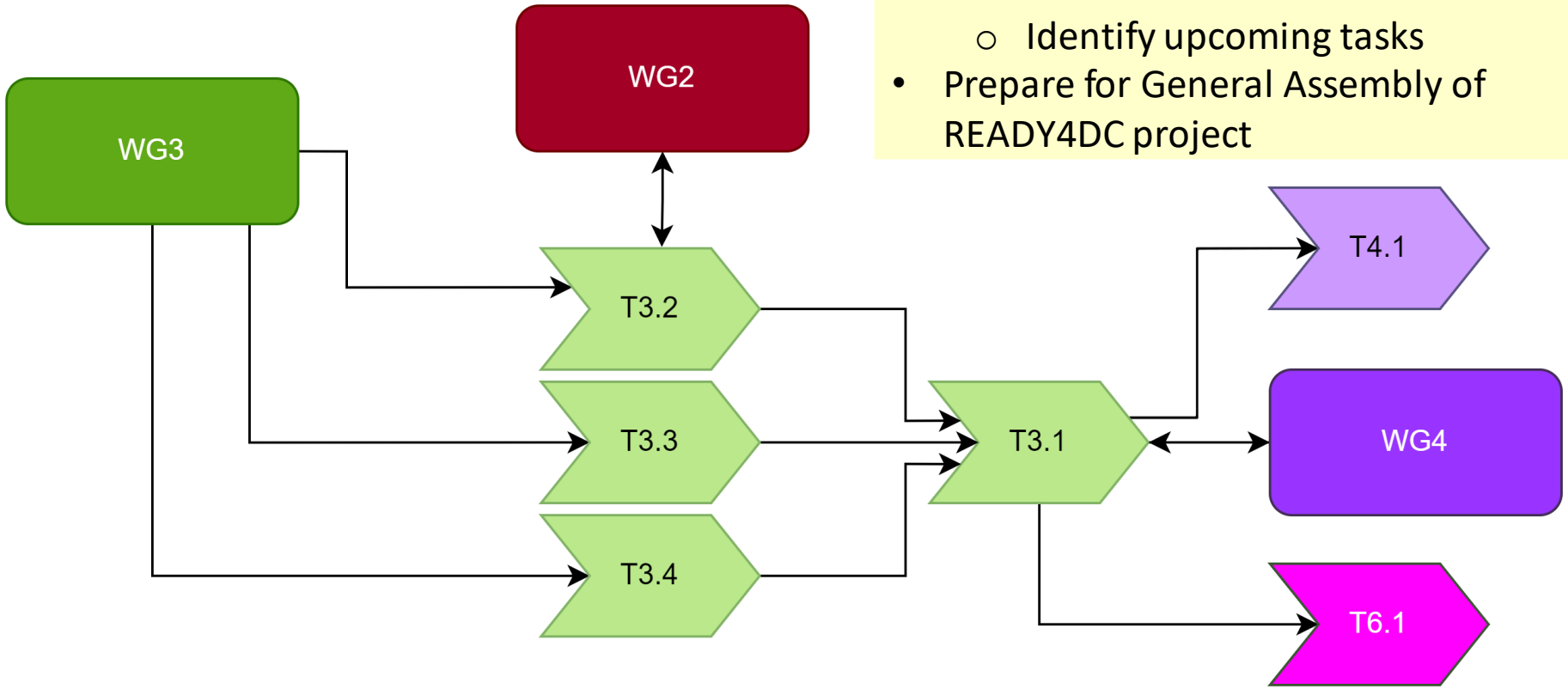
WP 3 split into Tasks



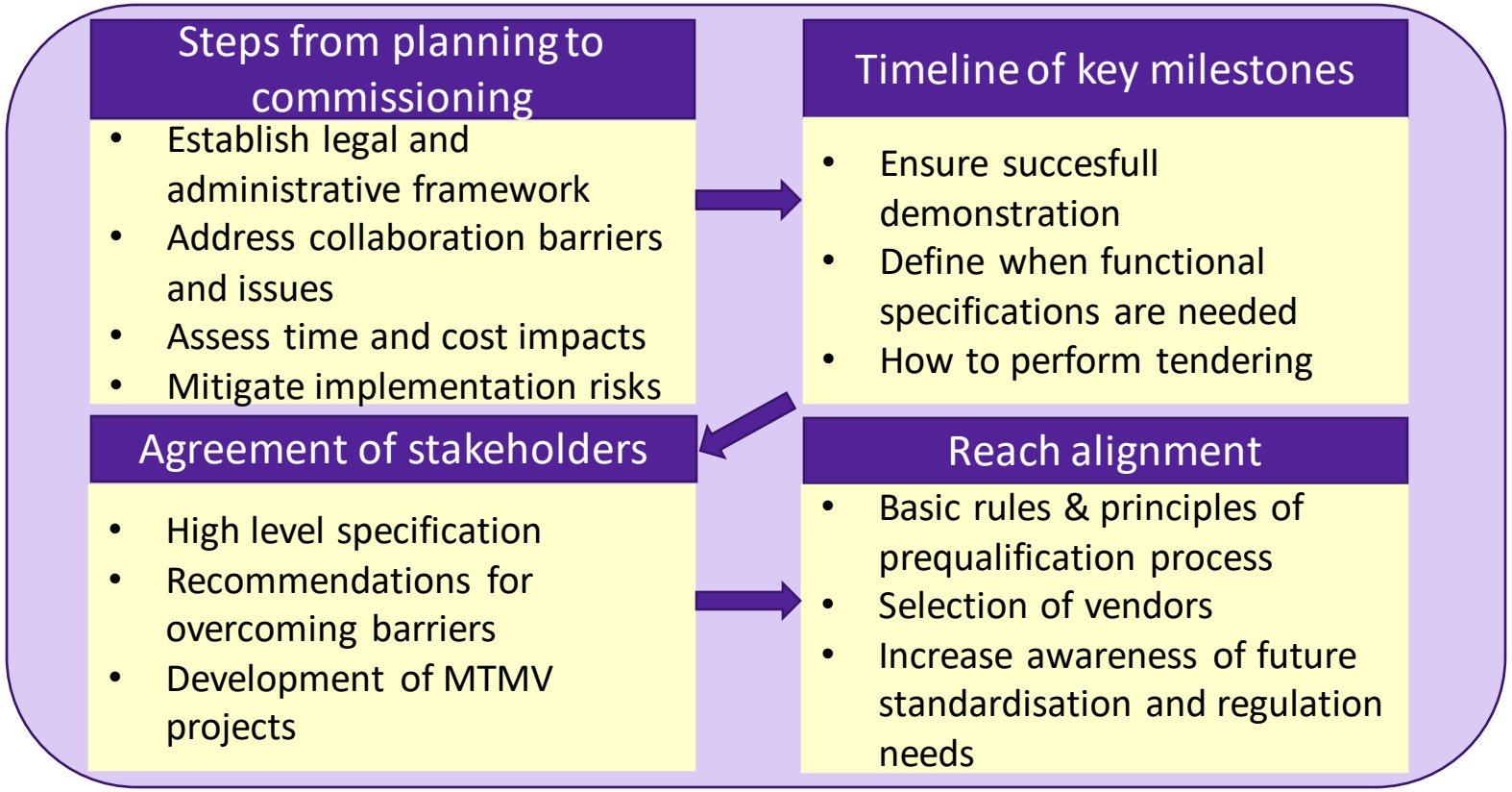
WP3 interactions

T3.1 Coordinate WG activities

- Reaching out to stakeholders
- Create with WG4 overarching picture
- Convene every two weeks
  - Status of advancement
  - Identify upcoming tasks
- Prepare for General Assembly of READY4DC project



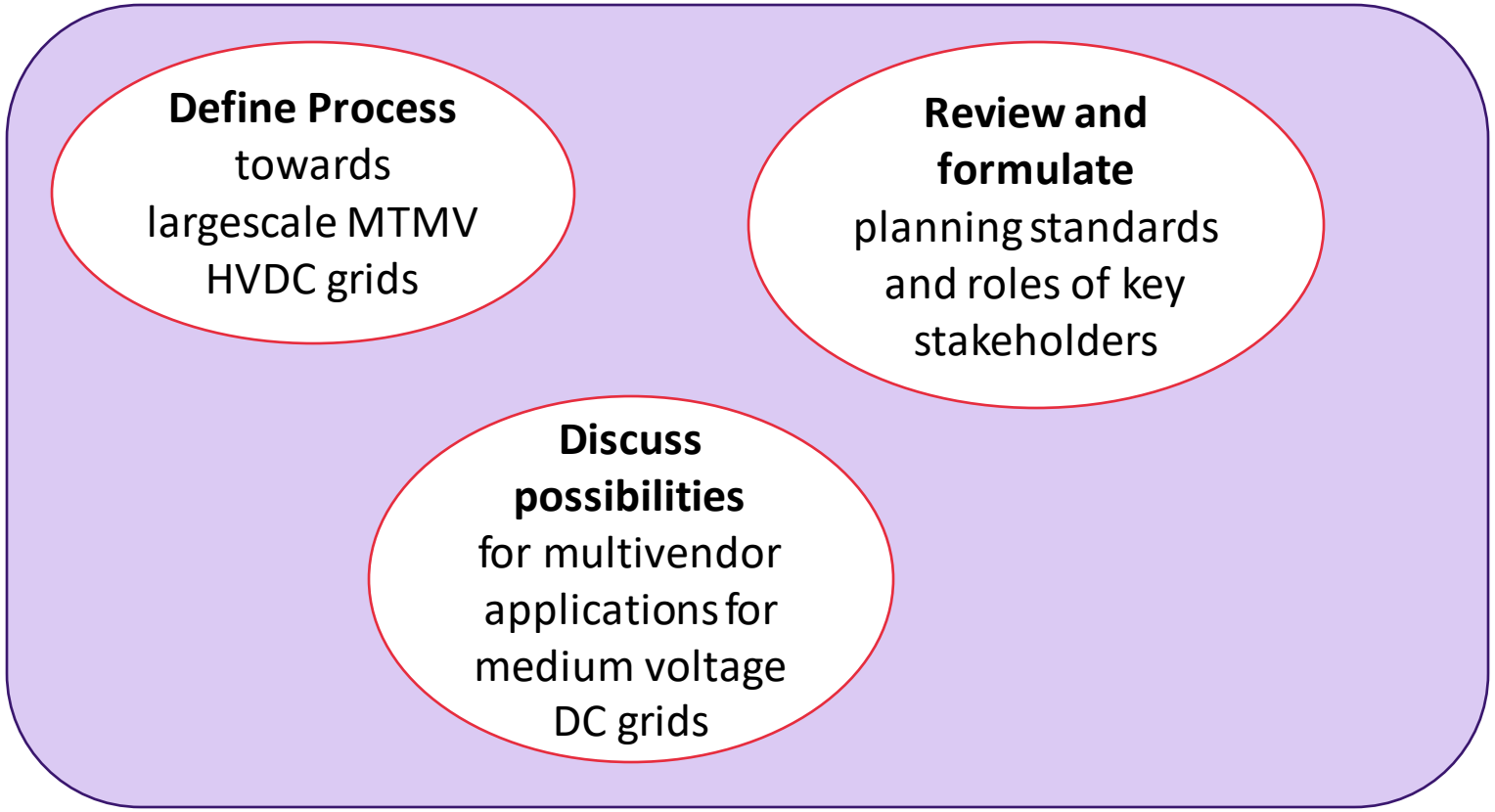
Task 3.2 / Planning the first multi-vendor HVDC demonstration project



Task 3.3 / Placing demonstrators in the European grid

- Selection criteria for potential full scale demonstration projects
- Identify type of demonstrator projects
- Dialog with potential project owners and direct stakeholders
  - Commitment
  - Support in TYNDP and PCI

Task 3.4 / Going beyond a demonstration project



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Current status

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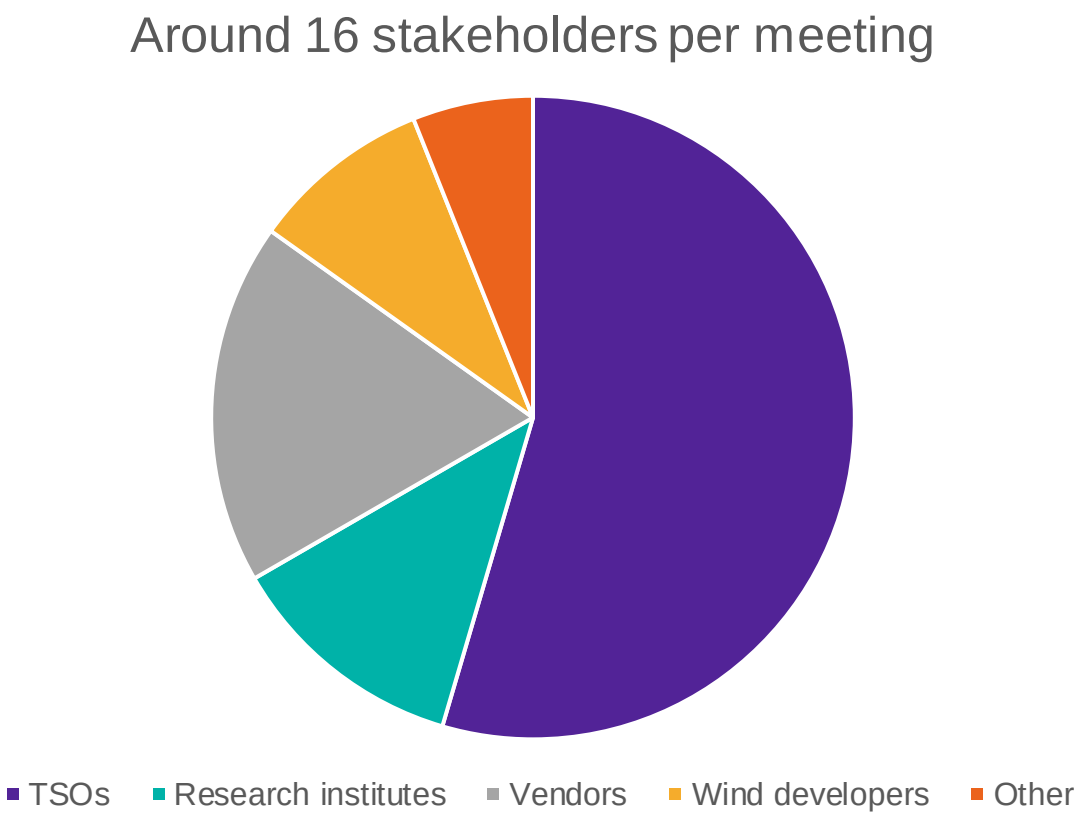
Preliminary Questions/Ideas for a MV-MT Demonstrator planning process

- What happens if we do not have a demonstrator project?
  - High investment → Unclear if the system will work (and will work over the entire lifetime)
  - Very conservative specification, more costly solution, security and quality of supply risk
- What will enable a system operator to create a MT/MV project?
  - Risk compensation
  - Direct promotion to key stakeholders
  - Requirements

Meeting member statistics



READY4DC project updates – call for nominations

- Aim of publicly available development of specifications
  - not only project partners but other institutions asked to contribute
  - Reach out to:
    - WG 3 leader Wilhelm Winter (wilhelm.winter@tennet.eu) for development of demonstrator projects
    - Paulius Butkus (paulius.butkus@entsoe.eu) for interest in the other WPs
- Project website: https://www.ready4dc.eu/

Thank you!
Any questions?

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WG4 on Framing the Future European Energy System (Lead: RWTH Aachen University)

Ilka Jahn (Chair) & Dimitar Kolichev, Nuno Souzo e Silva (Co-Chairs)

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Dr. Ilka Jahn, RWTH Aachen University

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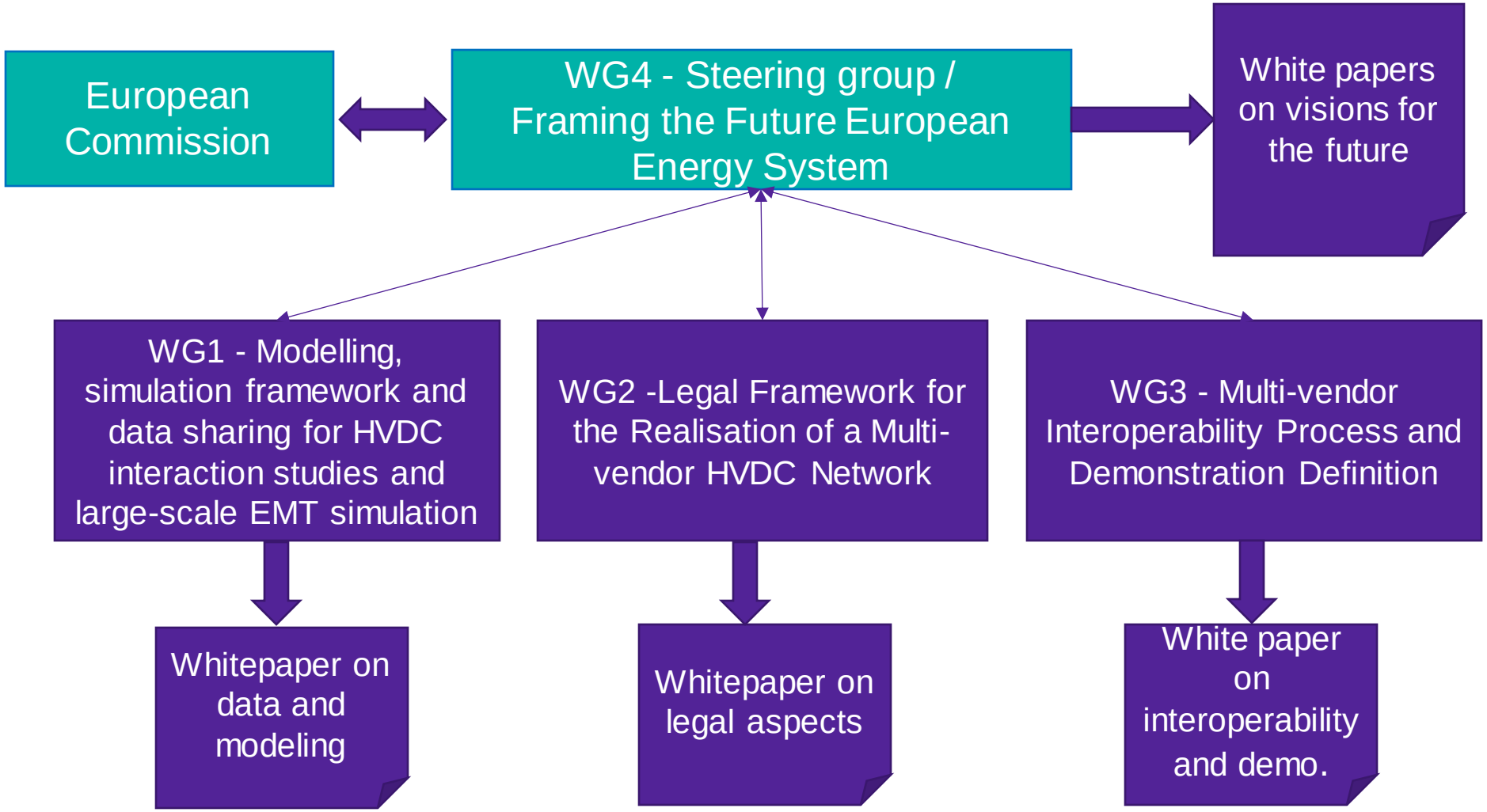
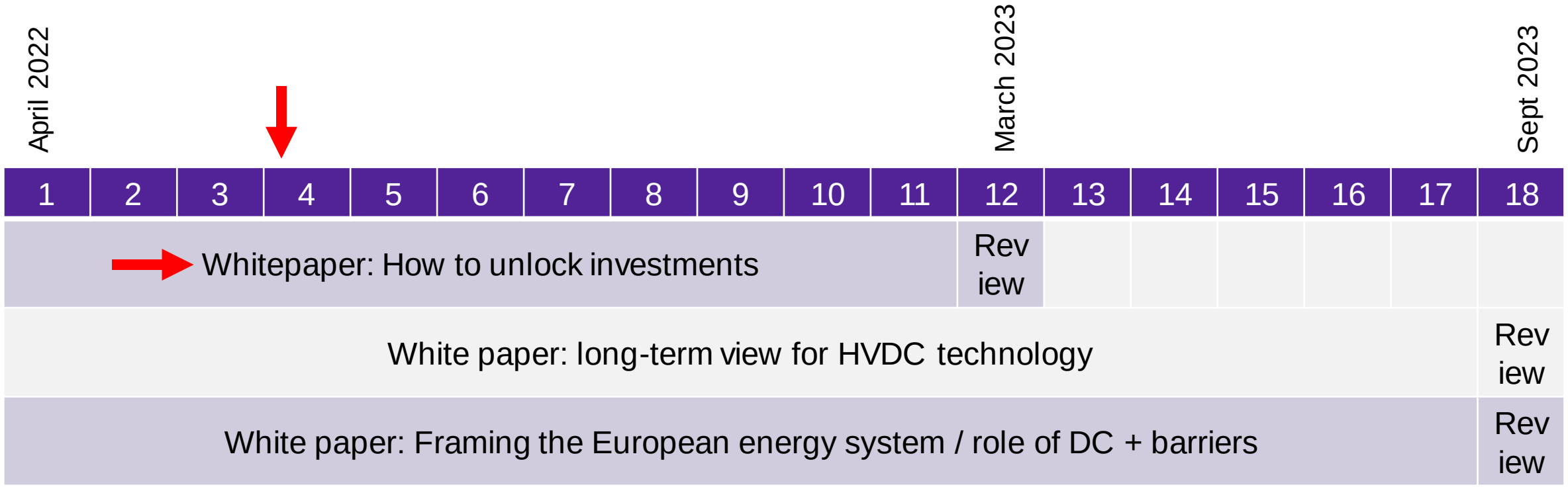
Project Structure



Scope

- WG4 extracts from the work done in the other WGs, and formulates the major lessons learned in the process of shaping a vision that will enable the future energy system in Europe. As such WG4 will provide the key components of exploitation for the project.
- Three whitepapers:
    1. Whitepaper on how to unlock investments for the first full-scale multi-vendor HVDC systems demonstration (March 2023). The key element is the definition of the financing framework to provide the sufficient de-risking initiative for full-scale multi-vendor HVDC system demonstration.
    2. White paper on long-term view for HVDC technology (September 2023)
    3. White paper on framing the European energy system (on- off-shore) architecture and topology: future role of meshed DC structures and barriers (September 2023)

Timeline



Additional: Involvement in BRIDGE and SetPlan activities

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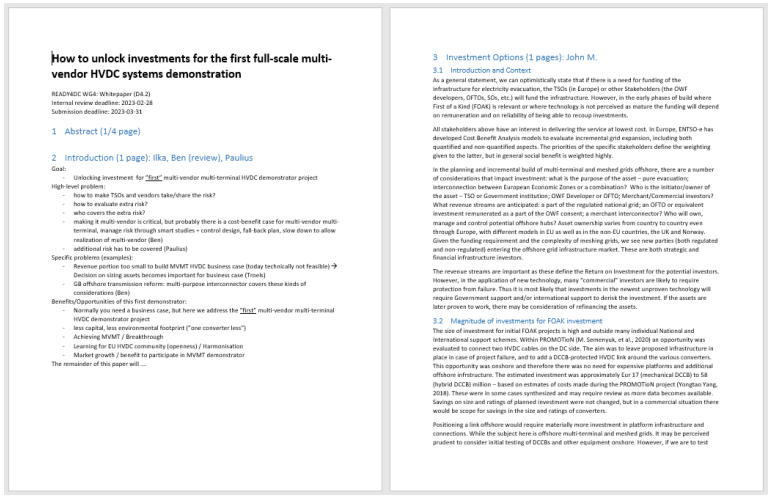
Preliminary Results

- Whitepaper: How to unlock investments for the first full-scale multi-vendor HVDC systems
  - Structure
  - Good discussions
  - Some thoughts
    - Sophisticated funding options are available
    - Less about „unlocking investments“ – more about „de-risking“
    - Main challenge: Need for risk compensation

Preliminary Results



How to unlock investments for the first full-scale multi-vendor HVDC systems demonstration

READY4DC WG4: Whitepaper (D4.2)
Internal review deadline: 2023-02-28
Submission deadline: 2023-03-31

1 Abstract (1/4 page)

2 Introduction (1 page): Ilka, Ben (review), Paulius

Goal:
- Unlocking investment for "first" multi-vendor multi-terminal HVDC demonstrator project

High-level problem :
- how to make TSOs and vendors take/share the risk?
- how to evaluate extra risk?
- who covers the extra risk?
- making it multi-vendor is critical, but probably there is a cost-benefit case for multi-vendor multi-terminal, manage risk through smart studies + control design, fall-back plan, slow down to allow realization of multi-vendor (Ben)
- additional risk has to be covered (Paulius)

Specific problems (examples):
- Revenue portion too small to build MVMT HVDC business case (today technically not feasible) →
- Decision on sizing assets becomes important for business case (Troels)
- GB offshore transmission reform: multi-purpose interconnector covers these kinds of considerations (Ben)

Benefits/Opportunities of this first demonstrator:
- Normally you need a business case, but here we address the "first" multi-vendor multi-terminal HVDC demonstrator project
- less capital, less environmental footprint ("one converter less")
- Achieving MVMT / Breakthrough
- Learning for EU HVDC community (openness) / Harmonisation
- Market growth / benefit to participate in MVMT demonstrator

The remainder of this paper will …

3 Investment Options (1 pages): John M.

3.1 Introduction and Context

As a general statement, we can optimistically state that if there is a need for funding of the infrastructure for electricity evacuation, the TSOs (in Europe) or other Stakeholders (the OWF developers, OFTOs, SOs, etc.) will fund the infrastructure. However, in the early phases of build where First of a Kind (FOAK) is relevant or where technology is not perceived as mature the funding will depend on remuneration and on reliability of being able to recoup investments.

All stakeholders above have an interest in delivering the service at lowest cost. In Europe, ENTSO-e has developed Cost Benefit Analysis models to evaluate incremental grid expansion, including both quantified and non-quantified aspects. The priorities of the specific stakeholders define the weighting given to the latter, but in general social benefit is weighted highly.

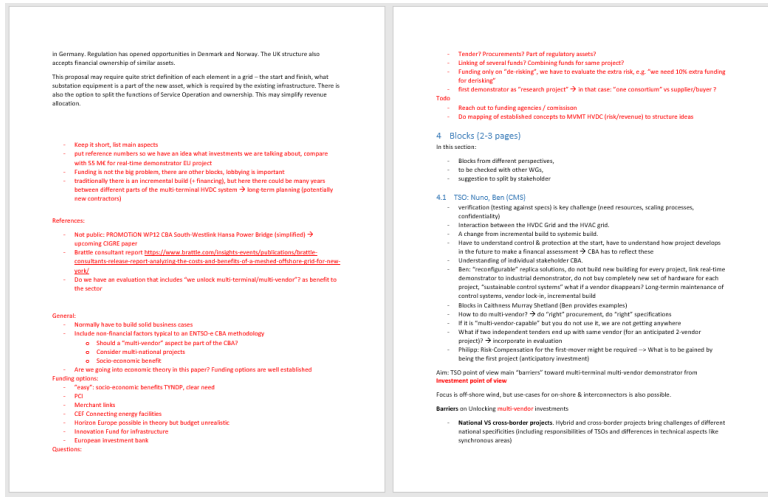
In the planning and incremental build of multi-terminal and meshed grids offshore, there are a number of considerations that impact investment: what is the purpose of the asset – pure evacuation; interconnection between European Economic Zones or a combination? Who is the initiator/owner of the asset – TSO or Government institution; OWF Developer or OFTO; Merchant/Commercial investors? What revenue streams are anticipated: a part of the regulated national grid; an OFTO or equivalent investment remunerated as a part of the OWF consent; a merchant interconnector? Who will own, manage and control potential offshore hubs? Asset ownership varies from country to country even through Europe, with different models in EU as well as in the non-EU countries, the UK and Norway. Given the funding requirement and the complexity of meshing grids, we see new parties (both regulated and non-regulated) entering the offshore grid infrastructure market. These are both strategic and financial infrastructure investors.

The revenue streams are important as these define the Return on Investment for the potential investors. However, in the application of new technology, many "commercial" investors are likely to require protection from failure. Thus it is most likely that investments in the newest unproven technology will require Government support and/or international support to derisk the investment. If the assets are later proven to work, there may be consideration of refinancing the assets.

3.2 Magnitude of investments for FOAK investment

The size of investment for initial FOAK projects is high and outside many individual National and International support schemes. Within PROMOTIoN (M. Somervuk, et al., 2020) an opportunity was evaluated to connect two HVDC cables on the DC side. The aim was to leave proposed infrastructure in place in case of project failure, and to add a DCCB-protected HVDC link around the various converters. This opportunity was onshore and therefore there was no need for expensive platforms and additional offshore infrstructure. The estimated investment was approximately Eur 17 (mechanical DCCB) to 58 (hybrid DCCB) million – based on estimates of costs made during the PROMOTIoN project (Yongtao Yang, 2018). These were in some cases synthesized and may require review as more data becomes available. Savings on size and ratings of planned investment were not changed, but in a commercial situation there would be scope for savings in the size and ratings of converters.

Positioning a link offshore would require materially more investment in platform infrastructure and connections. While the subject here is offshore multi-terminal and meshed grids. It may be perceived prudent to consider initial testing of DCCBs and other equipment onshore. However, if we are to test



in Germany. Regulation has opened opportunities in Denmark and Norway. The UK structure also accepts financial ownership of similar assets.

This proposal may require quite strict definition of each element in a grid – the start and finish, what substation equipment is a part of the new asset, which is required by the existing infrastructure. There is also the option to split the functions of Service Operation and ownership. This may simplify revenue allocation.

- Keep it short, list main aspects
- put reference numbers so we have an idea what investments we are talking about, compare with 55 M€ for real-time demonstrator EU project
- Funding is not the big problem, there are other blocks, lobbying is important
- traditionally there is an incremental build (+ financing), but here there could be many years between different parts of the multi-terminal HVDC system → long-term planning (potentially new contractors)

References:

- Not public: PROMOTION WP12 CBA South-Westlink Hansa Power Bridge (simplified) → upcoming CIGRE paper
- Brattle consultant report https://www.brattle.com/insights-events/publications/brattle-consultants-release-report-analyzing-the-costs-and-benefits-of-a-meshed-offshore-grid-for-new-york/
- Do we have an evaluation that includes "we unlock multi-terminal/multi-vendor"? as benefit to the sector

General:

- Normally have to build solid business cases
- Include non-financial factors typical to an ENTSO-e CBA methodology
  - Should a "multi-vendor" aspect be part of the CBA?
  - Consider multi-national projects
  - Socio-economic benefit
- Are we going into economic theory in this paper? Funding options are well established

Funding options:

- "easy": socio-economic benefits TYNDP, clear need
- PCI
- Merchant links
- CEF Connecting energy facilities
- Horizon Europe possible in theory but budget unrealistic
- Innovation Fund for infrastructure
- European investment bank

Questions:

- Tender? Procurements? Part of regulatory assets?
- Linking of several funds? Combining funds for same project?
- Funding only on "de-risking", we have to evaluate the extra risk, e.g. "we need 10% extra funding for derisking"
- first demonstrator as "research project" → in that case: "one consortium" vs supplier/buyer ?

Todo

- Reach out to funding agencies / comission
- Do mapping of established concepts to MVMT HVDC (risk/revenue) to structure ideas

4 Blocks (2-3 pages)

In this section:

- Blocks from different perspectives,
- to be checked with other WGs,
- suggestion to split by stakeholder

4.1 TSO: Nuno, Ben (CMS)

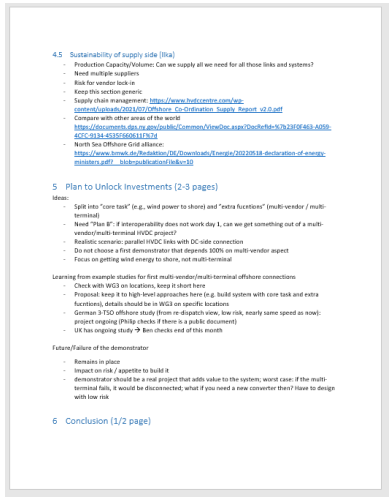
- verification (testing against specs) is key challenge (need resources, scaling processes, confidentiality)
- Interaction between the HVDC Grid and the HVAC grid.
- A change from incremental build to systemic build.
- Have to understand control & protection at the start, have to understand how project develops in the future to make a financial assessment → CBA has to reflect these
- Understanding of individual stakeholder CBA
- Ben: "reconfigurable" replica solutions, do not build new building for every project, link real-time demonstrator to industrial demonstrator, do not buy completely new set of hardware for each project, "sustainable control systems" what if a vendor disappears? Long-termin maintenance of control systems, vendor lock-in, incremental build
- Blocks in Caithness Murray Shetland (Ben provides examples)
- How to do multi-vendor? → do "right" procurement, do "right" specifications
- If it is "multi-vendor-capable" but you do not use it, we are not getting anywhere
- What if two independent tenders end up with same vendor (for an anticipated 2-vendor project)? → incorporate in evaluation
- Philipp: Risk Compensation for the first-mover might be required --> What is to be gained by being the first project (anticipatory investment)

Aim: TSO point of view main "barriers" toward multi-terminal multi-vendor demonstrator from **investment point of view**

Focus is off-shore wind, but use-cases for on-shore & interconnectors is also possible.

Barriers on Unlocking multi-vendor investments

- **National VS cross-border projects**. Hybrid and cross-border projects bring challenges of different national specificities (including responsibilities of TSOs and differences in technical aspects like synchronous areas)



4.5 Sustainability of supply side (Ilka)

- Production Capacity/Volumn: Can we supply all we need for all those links and systems?
- Need multiple suppliers
- Risk for vendor lock-in
- Keep this section generic
- Supply chain management: https://www.hvdccentre.com/wp-content/uploads/2021/07/Offshore_Co-Ordination_Supply_Report_v2.0.pdf
- Compare with other areas of the world
  https://documents.rgs.ny.gov/pshlic/Common/ViewDoc.aspx?DocRefId=%7b23F0F463-A059-4CFC-9134-45357606E1E7%7d
  North Sea Offshore Grid alliance:
  https://www.bmwk.de/Redaktion/DE/Downloads/Energie/20220518-declaration-of-energy-ministers.pdf?__blob=publicationFile&v=10

5 Plan to Unlock Investments (2-3 pages)

Ideas:

- Split into "core task" (e.g., wind power to shore) and "extra fucetions" (multi-vendor / multi-terminal)
- Need "Plan B": if interoperability does not work day 1, can we get something out of a multi-vendor/multi-terminal HVDC project?
- Realistic scenario; parallel HVDC links with DC-side connection
- Do not choose a first demonstrator that depends 100% on multi-vendor aspect
- Focus on getting wind energy to shore, not multi-terminal

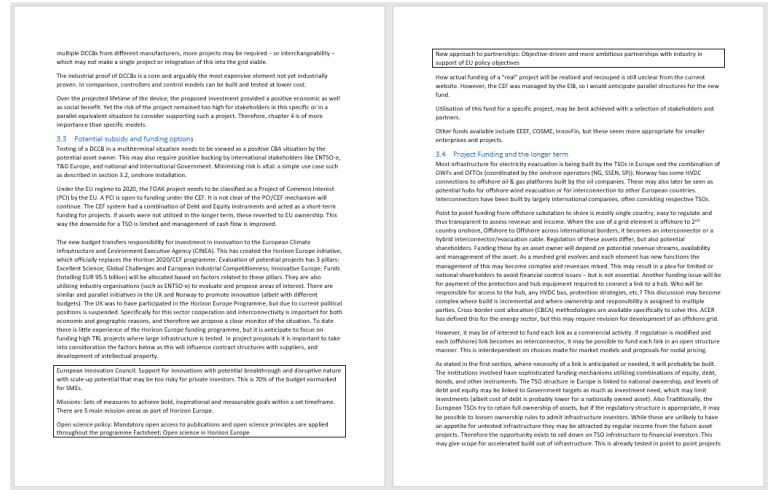
Learning from example studies for first multi-vendor/multi-terminal offshore connections

- Check with WG3 on locations, keep it short here
- Proposal: keep it to high-level approaches here (e.g. build system with core task and extra fucntions), details should be in WG3 on specific locations
- German 3 TSO offshore study (from re-dispatch view, low risk, nearly same speed as now): project ongoing (Philip checks if there is a public document)
- UK has ongoing study → Ben checks end of this month

Future/Failure of the demonstrator

- Remains in place
- Impact on risk / appetite to build it
- demonstrator should be a real project that adds value to the system; worst case: if the multi-terminal fails, it would be disconnected; what if you need a new converter then? Have to design with low risk

6 Conclusion (1/2 page)



multiple DCCBs from different manufacturers, more projects may be required – or interchangeability – which may not make a single project or integration of this into the grid viable.

The industrial proof of DCCBs is a core and arguably the most expensive element not yet industrially proven. In comparison, controllers and control models can be built and tested at lower cost.

Over the projected lifetime of the device, the proposed investment provided a positive economic as well as social benefit. Yet the risk of the project remained too high for stakeholders in this specific or in a parallel equivalent situation to consider supporting such a project. Therefore, chapter 4 is of more importance than specific models.

3.3 Potential subsidy and funding options

Testing of a DCCB in a multiterminal situation needs to be viewed as a positive CBA situation by the potential asset owner. This may also require positive backing by international stakeholders like ENTSO-e, T&D Europe, and national and International Government. Minimising risk is vital: a simple use case such as described in section 3.2, onshore installation.

Under the EU regime to 2020, the FOAK project needs to be classified as a Project of Common Interest (PCI) by the EU. A PCI is open to funding under the CEF. It is not clear of the PCI/CEF mechanism will continue. The CEF system had a combination of Debt and Equity instruments and acted as a short-term funding for projects. If assets were not utilized in the longer term, these reverted to EU ownership. This way the downside for a TSO is limited and management of cash flow is improved.

The new budget transfers responsibility for investment in innovation to the European Climate Infrastructure and Environment Executive Agency (CINEA). This has created the Horizon Europe initiative, which officially replaces the Horizon 2020/CEF programme. Evaluation of potential projects has 3 pillars: Excellent Science; Global Challenges and European Industrial Competitiveness; Innovative Europe. Funds (totalling EUR 95.5 billion) will be allocated based on factors related to these pillars. They are also utilizing industry organisations (such as ENTSO-e) to evaluate and propose areas of interest. There are similar and parallel initiatives in the UK and Norway to promote innovation (albeit with different budgets). The UK was to have participated in the Horizon Europe Programme, but due to current political positions is suspended. Specifically for this sector cooperation and interconnectivity is important for both economic and geographic reasons, and therefore we propose a close monitor of the situation. To date there is little experience of the Horizon Europe funding programme, but it is anticipate to focus on funding high TRL projects where large infrastructure is tested. In project proposals it is important to take into consideration the factors below as this will influence contract structures with suppliers, and development of intellectual property.

European Innovation Council: Support for innovations with potential breakthrough and disruptive nature with scale-up potential that may be too risky for private investors. This is 70% of the budget earmarked for SMEs.

Missions: Sets of measures to achieve bold, inspirational and measurable goals within a set timeframe. There are 5 main mission areas as part of Horizon Europe.

Open science policy: Mandatory open access to publications and open science principles are applied throughout the programme Factsheet: Open science in Horizon Europe

New approach to partnerships: Objective-driven and more ambitious partnerships with industry in support of EU policy objectives

How actual funding of a "real" project will be realized and recouped is still unclear from the current website. However, the CEF was managed by the EIB, so I would anticipate parallel structures for the new fund.

Utilisation of this fund for a specific project, may be best achieved with a selection of stakeholders and partners.

Other funds available include EEEF, COSME, InnovFin, but these seem more appropriate for smaller enterprises and projects.

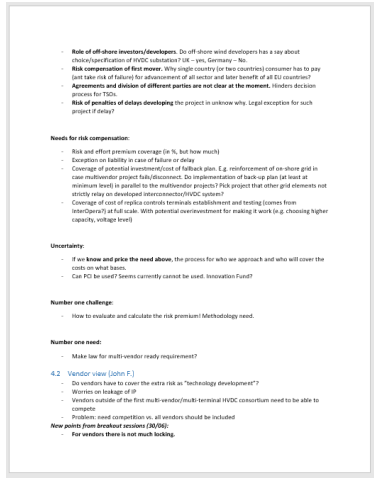
3.4 Project Funding and the longer term

Most infrastructure for electricity evacuation is being built by the TSOs in Europe and the combination of OWFs and OFTOs (coordinated by the onshore operators (NG, SSEN, SPI). Norway has some HVDC connections to offshore oil & gas platforms built by the oil companies. These may also later be seen as potential hubs for offshore wind evacuation or for interconnection to other European countries. Interconnectors have been built by largely international companies, often consisting respective TSOs.

Point to point funding from offshore substation to shore is mostly single country, easy to regulate and thus transparent to assess revenue and income. When the use of a grid element is offshore to 2nd country onshore, Offshore to Offshore across international borders, it becomes an interconnector or a hybrid interconnector/evacuation cable. Regulation of these assets differ, but also potential shareholders. Funding these by an asset owner will depend on potential revenue streams, availability and management of the asset. As a meshed grid evolves and each element has new functions the management of this may become complex and revenues mixed. This may result in a plea for limited or national shareholders to avoid financial control issues – but is not essential. Another funding issue will be for payment of the protection and hub equipment required to connect a link to a hub. Who will be responsible for access to the hub, any HVDC bus, protection strategies, etc.? This discussion may become complex where build is incremental and where ownership and responsibility is assigned to multiple parties. Cross-border cost allocation (CBCA) methodologies are available specifically to solve this. ACER has defined this for the energy sector, but this may require revision for development of an offshore grid.

However, it may be of interest to fund each link as a commercial activity. If regulation is modified and each (offshore) link becomes an interconnector, it may be possible to fund each link in an open structure manner. This is interdependent on choices made for market models and proposals for nodal pricing.

As stated in the first section, where necessity of a link is anticipated or needed, it will probably be built. The institutions involved have sophisticated funding mechanisms utilising combinations of equity, debt, bonds, and other instruments. The TSO structure in Europe is linked to national ownership, and levels of debt and equity may be linked to Government targets as much as investment need, which may limit investments (albeit cost of debt is probably lower for a nationally owned asset). Also Traditionally, the European TSOs try to retain full ownership of assets, but if the regulatory structure is appropriate, it may be possible to loosen ownership rules to admit infrastructure investors. While these are unlikely to have an appetite for untested infrastructure they may be attracted by regular income from the future asset projects. Therefore the opportunity exists to sell down on TSO infrastructure to financial investors. This may give scope for accelerated build out of infrastructure. This is already tested in point to point projects



- **Role of off-shore investors/developers**. Do off-shore wind developers has a say about choice/specification of HVDC substation? UK – yes, Germany – No.
- **Risk compensation of first mover.** Why single country (or two countries) consumer has to pay (ant take risk of failure) for advancement of all sector and later benefit of all EU countries?
- **Agreements and division of different parties are not clear at the moment.** Hinders decision process for TSOs.
- **Risk of penalties of delays developing** the project in unknow why. Legal exception for such project if delay?

Needs for risk compensation:

- Risk and effort premium coverage (ie %, but how much)
- Exception on liability in case of failure or delay
- Coverage of potential investment/cost of fallback plan. E.g. reinforcement of on-shore grid in case multivendor project fails/disconnect. Do implementation of back-up plan (at least at minimum level) in parallel to the multivendor projects? Pick project that other grid elements not strictly relay on developed interconnector/HVDC system?
- Coverage of cost of replica controls terminals establishment and testing (comes from InterOpera?) at full scale. With potential overinvestment for making it work (e.g. choosing higher capacity, voltage level)

Uncertainty:

- If we **know and price the need above**, the process for who we approach and who will cover the costs on what bases.
- Can PCI be used? Seems currently cannot be used. Innovation Fund?

Number one challenge:

- How to evaluate and calculate the risk premium! Methodology need.

Number one need:

- Make law for multi-vendor ready requirement?

4.2 Vendor view (John F.)

- Do vendors have to cover the extra risk as "technology development"?
- Worries on leakage of IP
- Vendors outside of the first multi-vendor/multi-terminal HVDC consortium need to be able to compete
- Problem: need competition vs. all vendors should be included

New points from breakout sessions (30/06):

- **For vendors there is not much locking.**
  - Unlocking investments is not really the task of the vendors – if we see a business opportunity, we will take it.
  - Confidence needs to be built in the market (e.g. by TSOs/states/other developers/financial institutions) that would allow us to invest in R&D. We need to know that we will get orders and capitalize on returns.
- **Main risk for vendors:**
  - Lack of guarantees that when vendors invest money and time in R&D, it becomes stranded.
    - E.g: Offshore generation will rise and will be in such proximity that the MV MT HVDC connections will be needed – the businesses will come either way, but we still need financial signals.
  - We understand that for TSOs the main risk is associated with avoiding stranded assets.
  - Solution lies in the joint effort from all stakeholders – once the first (several first) demonstrators are successful, vendors will have the necessary certainty.
    - Examples and best practices can be sought ought also from other regions outside of the EU: projects and studies from China, Japan, etc. (considerations: public information is hardly available, different contexts, different law frameworks and market types)
- So, not much a question of **'unlocking'**, but **'de-risking'**.
  - Technical/technological issues can be solved at a later stage (also a discussion for WG3, where a similar brainstorming could take place)
  - IP challenges are solvable as well, although they still are of very high importance, posing substantial risks.
  - The law needs to be addressed: how we can ensure that 3 European vendors are included and that the systems is compatible with everyone to allow them to work together and take the maximum technical advantage (main difference in comparison with other regions of the world: competition and procurement laws have their pros and cons). High importance of the READY4DC WG2.
- **Other challenges:** Insufficient experts in HVDC, power systems, etc.

4.3 Wind developer view

4.4 Permit structures → no action, wait for WG2 and check with Vincent

- Challenging: in Multi-country setup
- GB East Anglia area: projects have to coordinate, learn form that region, "easy landing point"
- Simplification: Anticipatory investment now possible UK
- Netherlands working on simplification
- US: requirements on coordination for HVDC projects (e.g., extendable on AC side)

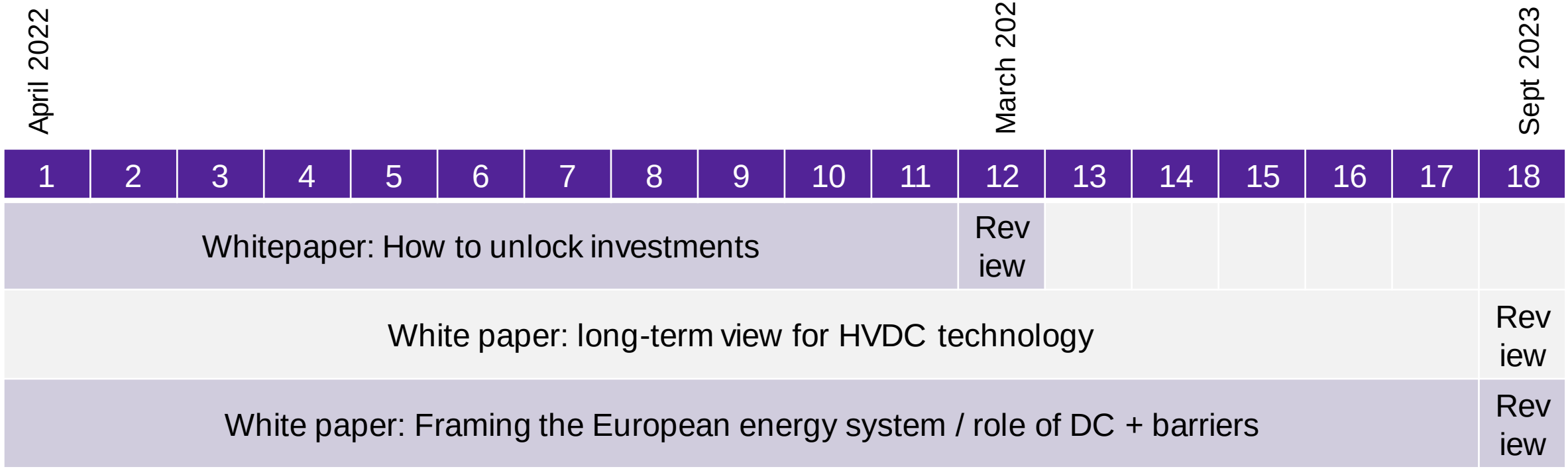
Environmental / Public acceptance: Worth bringing out, but keep it short

READY4DC

ready4dc.eu

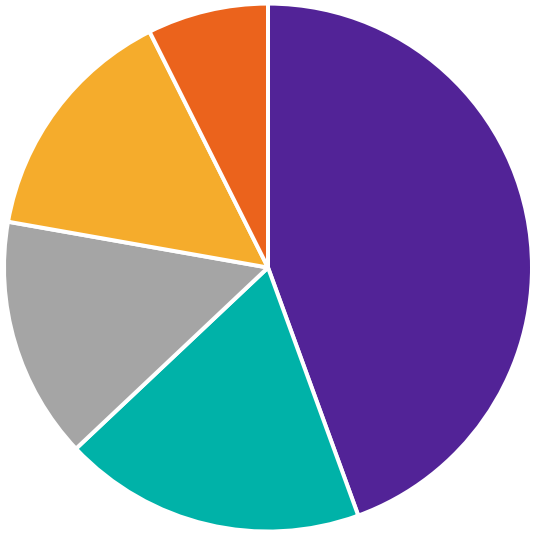
Next Steps

- Until Mid-August: Brainstorming Long-term view HVDC / Future Energy System
- From Mid-August: Whitepaper "how to unlock investments"



Member Statistics

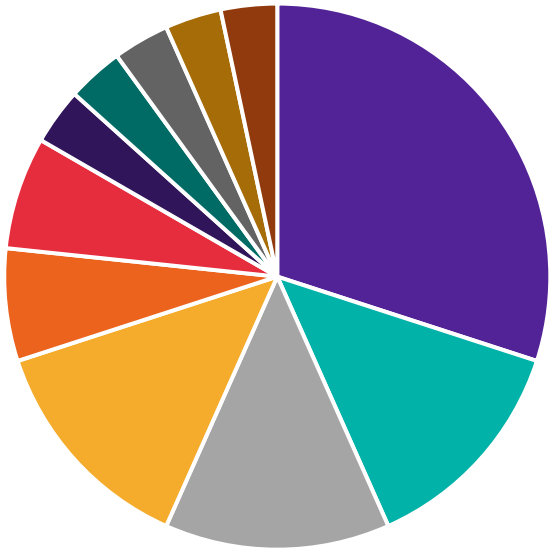
Stakeholders



- TSOs
- Vendors
- Wind developers
- Universities/Research institutes
- Consultancies/Other

Meeting attendance:
16-18 persons

Countries



- Germany
- UK
- Norway
- Belgium
- Netherlands
- Denmark
- Lithuania
- Portugal
- France
- Sweden
- Non-EU

READY4DC

Join us!

- WG4 on Framing the Future European Energy System
- Bi-weekly meetings Thursday 12:00-13:30 CEST
- ilka.jahn@eonerc.rwth-aachen.de
- More information: www.READY4DC.eu

Open Discussion

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