PROMOTioN
PROGRESS ON MESHED HVDC OFFSHORE TRANSMISSION NETWORKS

D14.5 Exploitation of Results

PROMOTioN – Progress on Meshed HVDC Offshore Transmission Networks
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Work Package and deliverable involve a large number of partners and contributors. The names of the partners, who contributed to the present deliverable, are presented in the following table.

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CONTENT

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1 INTRODUCTION

1.1 BACKGROUND

In the course of the ratification of the Kyoto protocol in 2005, the presidency conclusions of the Council of the European Union (EU) included a proposal for “an integrated climate and energy policy”. The objective of this policy is to limit “the global average temperature increase to not more than 2°C above pre-industrial levels”. In addition, the Paris agreement reaffirms the goal of limiting the global temperature increase to not more than 2°C, "while urging efforts to limit the increase to 1.5°C".

Besides other initiatives e.g. to lower the consumption of electrical energy, the presidency conclusions include “a binding target of a 20% share of renewable energies in overall EU energy consumption by 2020” to reach its goal. In 2014, several renewed targets were communicated by the EU in their climate and energy framework 2030, as follows:

TARGETS FOR 2030

- a 40% cut in greenhouse gas emissions compared to 1990 levels
- at least a 27% share of renewable energy consumption
- indicative target for an improvement in energy efficiency at EU level of at least 27% (compared to projections), to be reviewed by 2020 (with an EU level of 30% in mind)
- support the completion of the internal energy market by achieving the existing electricity interconnection target of 10% by 2020, with a view to reaching 15% by 2030

In June 2018, EU ambassadors endorsed the Clean Energy for all Europeans package that sets a target of 32% energy from renewable sources at EU level for 2030. Additionally, in 2019 the EU communicated in the European Green Deal its wish to increase the climate ambition to at least 50 and towards 55% reductions in greenhouse gas emissions, in order to be more in line with the Paris agreement.

Northern Europe has vast offshore wind potential, which is able to support these objectives. However, the integration of wind energy generated offshore into the onshore energy system remains a challenge on various levels. Challenges include long and increasing lead times for the installation of capacity and connection[1], the development of robust technology to operate the network securely and safely, the current legal & regulatory framework that is insufficient to fully support offshore infrastructure, the governmental structures that still follow national lines and economic and market conditions that discourage cooperation. One option to meet the requirements in terms of climate and energy policies is the establishment of a High Voltage Direct Current (HVDC) Meshed Offshore Grid (MOG). An HVDC MOG is formed by interconnecting offshore wind farms (OWFs) with different onshore systems on the DC side, such that more than one path exists between any two nodes, creating redundancy and increasing availability. The MOG would also be very

[1] Due in part to increasing consultation periods. To date, industry has been able to scale itself to deliver reasonably on time, once the construction phase is reached.

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suitable to combine the evacuation of offshore wind energy and facilitate the exchange of power between different countries, contributing to two of the EU strategic goals. HVDC is chosen above the more widely used Alternating Current (AC) connections as offshore subsea cables must be used as distances become greater. The use of HVDC therefore vastly increases the maximum allowable transmission distance while reducing transmission losses.

In previous research studies and EU-funded projects, different challenges for the development of offshore grids have been identified:

- On a technical level there remains a lack of agreement among operators and manufacturers on system architecture, control structures, protection schemes and interfaces to ensure interoperability and multi-vendor compatibility of equipment.
- On a regulatory level there is a lack of market rules for infrastructure investments and ownership as well as a lack of regulation regarding the operation and management of these grids from the legal, technical and market point of view. Furthermore, additional barriers are linked specifically to the regulation of an HVDC MOG (e.g. control issues).

1.2 THE PROMOTION PROJECT

The ultimate goal of the PROMOTioN Project is to contribute to unlocking the full potential of Europe's offshore resources. Network infrastructure is urgently required, linking off-shore wind parks and on-shore grids in different countries. HVDC technology is envisaged but the deployment of meshed HVDC offshore grids is currently hindered by the high cost of offshore converter technology, lack of experience with protection systems and fault clearance components and immature international regulations and financial instruments. The PROMOTioN project has identified gaps in technology and non-technological issues and has designed a programme to alleviate some of these critical challenges.

The project has twelve research and laboratory test programmes, referred to as Work Packages (WPs), that each tackle specific technical and regulatory barriers that have been identified. PROMOTioN has researched and tested four key HVDC technologies, namely control systems, DC Circuit Breakers (DCCBs), HVDC protection systems and Gas Insulated Switchgear (GIS)[2]. To further decrease technological barriers, a work package where research aimed at harmonisation of the standardisation of these technologies to ensure interoperability of different combinations of infrastructure from different manufacturers, was also introduced. A policy recommendation package is also present that incorporates the legal, economic and financial frameworks that aim to solve all further barriers.

[2] A separate WP once also studied Diode Rectifier Units, but this WP was terminated during the project.

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1.3 MOTIVATION AND WORK

Within the H2020 Programme more importance is given to dissemination actions and exploitation of project results. This stems from Europe's ambitions to have improved value of Research & Innovation funding and more impact in society.

The H2020 rules state clear obligations for beneficiaries:

- "Subject to any restrictions due to the protection of intellectual property, security rules or legitimate interests, each participant shall through appropriate means disseminate the results it owns as soon as possible."
- "Each participant that has received Union funding shall use its best efforts to exploit the results it owns, or to have them exploited by another legal entity…"
- "… participants shall provide any information on their exploitation and dissemination related activities and provide any documents necessary in accordance with the conditions laid down in the grant agreement".

The purpose of this deliverable is thus to highlight the produced value and benefits brought forward by the research and work done by the beneficiaries individually in the PROMOTioN project. This report shows how the beneficiaries (plan to) exploit the results they have achieved through the project and how it will be disseminated.

This report builds on previous work done in deliverable 14.4 "Exploitation Plan", which was an intermediate report that did not capture the potential outcomes for all beneficiaries as they did not necessarily have full oversight over their results yet. Deliverable 14.4 was the official starting document that supported the further process of result exploitation towards project's end.

Working on the Exploitation of Results, two physical workshops have been organized. It was mandatory for a representative of each beneficiary to participate in at least one of them. The workshops took place in Aachen (Germany) in June 2019 and in Roskilde (Denmark) in December 2019. Both were organized through the Support Services of Exploitation of Research Results (SSERR) and led by Meta Consulting group[3], that employed the Exploitation Strategy Seminar (ESS) Framework.

During the autumn of 2019, four telco sessions with the beneficiaries were also arranged in relation to the reporting on Exploitation of Results. The purpose of these was to inform the partners further on what was expected of them in deploying the first efforts on project result exploitation and in its documenting.

PROMOTioN comprises a separate work package (WP12) that delivers a Deployment Plan for the future European Offshore grid. The deliverables from this work package integrate a lot of the research outcomes from the project and present how these results contribute to bringing the deployment of meshed HVDC grid closer to realization. The WP's central deliverable 'Final deployment plan for future European offshore grid

[3] http://sserr.meta-group.com/SitePages/default.aspx

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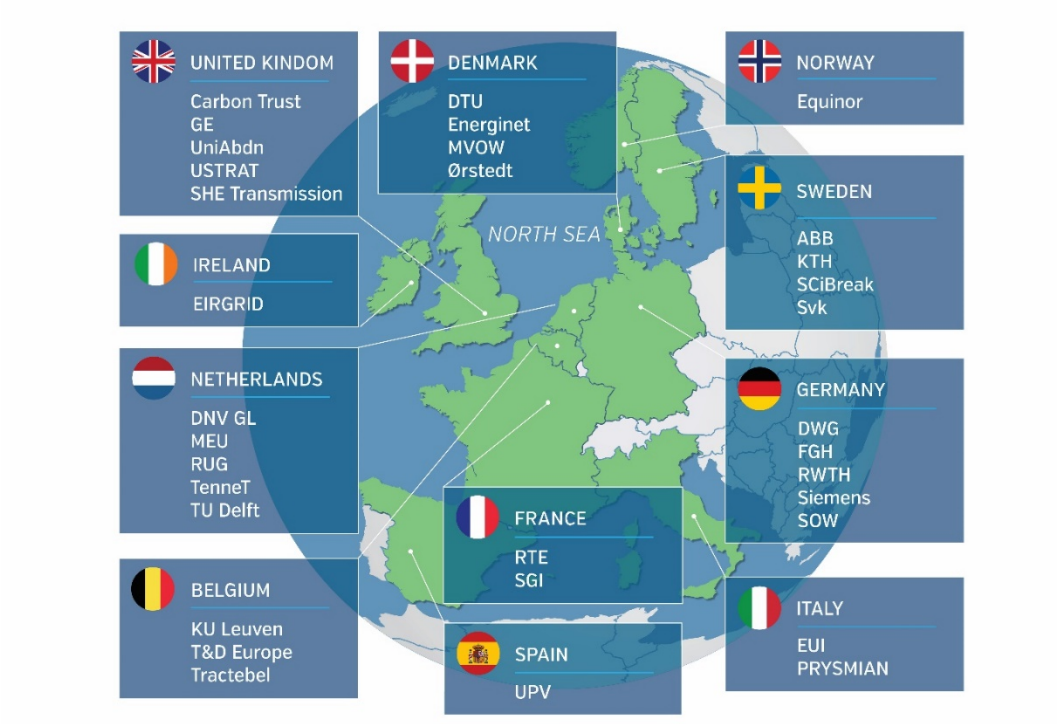
development' (D12.4) can be interpreted as an Exploitation Plan from the project's beneficiaries jointly when taking the perspective of the H2020 interest of Exploitation of Results as mentioned above.

There are however a large number of exploitable results that are not directly linked to a deployment plan for a future meshed offshore grid. Some of the results can also be utilized in areas that are not directly linked to offshore wind or grid development. This report captures the key exploitable results individually brought forward by each single beneficiary.

1.4 DOCUMENT OVERVIEW

This report starts with introductionary chapter 1 by giving context and background of PROMOTioN. Motivation, approach and process is provided towards the reported key exploitable results (KERs).
The following chapter 2 introduces the ESS framework that has been used by the beneficiaries for training and to structure and report on their key exploitable results. In chapter 3 the key exploitable results of the beneficiaries are presented.
In order to put the set of key exploitable results in the perspective of the project's core objetives, chapter 4 provides an overview how they contribute to these different objectives. The reports ends in chapter 5 with an list of abbreviations used.

1.5 LIST OF PARTICIPANTS IN THE PROMOTION PROJECT



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SHORT NAME	LEGAL NAME	COUNTRY
DNV GL	DNV GL Netherlands B.V.	Netherlands
KEMA	KEMA Netherlands B.V.	Netherlands
ABB	ABB AB	Sweden
KU Leuven	KU Leuven	Belgium
KTH	KTH Royal Institute of Technology	Sweden
EirGrid	EirGrid plc	Ireland
SGI	SuperGrid Institute	France
DWG	Deutsche WindGuard GmbH	Germany
MEU	Mitsubishi Electric Europe B.V.	Netherlands
Svk	Affärsverket Svenska kraftnät	Sweden
GE	Alstom Grid UK Ltd (Trading as GE Grid Solutions)	United Kingdom
UniAbdn	University of Aberdeen	United Kingdom
RTE	Réseau de Transport d'Électricité	France
TU Delft	Technische Universiteit Delft	Netherlands
Equinor	Equinor	Norway
TenneT	TenneT TSO B.V.	Netherlands
SOW	Stiftung OFFSHORE-WINDENERGIE	Germany
Siemens	Siemens AG	Germany
DTU	Danmarks Tekniske Universitet	Denmark
RWTH Aachen	Rheinisch-Westfälische Technische Hochschule Aachen	Germany
UPV	Universitat Politècnica de València	Spain
FGH	Forschungsgemeinschaft für. Elektrische Anlagen und Stromwirtschaft e.V.	Germany
Ørsted	Ørsted Wind Power A/S	Denmark
Carbon Trust	The Carbon Trust	United Kingdom
Tractebel	Tractebel Engineering S.A.	Belgium
EUI	European University Institute	Italy
T&D Europe	European Association of the Electricity Transmission & Distribution Equipment and Services Industry	Belgium
USTRAT	University of Strathclyde	United Kingdom
Prysmian	Prysmian	Italy
RUG	Rijksuniversiteit Groningen	Netherlands
MVOW	MHI Vestas Offshore Wind AS	Denmark
Energinet	Energinet.dk	Denmark
SHE Transmission	Scottish Hydro Electric Transmission plc	United Kingdom
SCiBreak	SCiBreak AB	Sweden

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2 INTRODUCING THE ESS

PROMOTioN has deployed the H2020 Support Services of Exploitation of Results (SSER) as key vehicle to advance on delivering project KERs. Their Exploitation Strategy Seminars provide excellent means to mobilizing organizations on their KER-efforts like methodologies and a commun language; these are elaborated on in this chapter. Most of the paragraphs in this chapter have been derived/copied from the materials provided by Meta Consulting group.

2.1 THE EXPLOITATION STRATEGY SEMINAR

The Exploitation Strategy Seminar (ESS) is a service for the partners of an H2020 energy research project allowing them to discuss the use of project results and their exploitation routes.

Project and the research work done or to be done in the future are considered in terms of key exploitable results. These are results, which have commercial and/or societal significance. The results selected for the discussion during the ESS are characterised from a viewpoint which is exploitation only, how they will be used to generate an impact. This is the market/customer demand or societal needs/user point of view. For each of them, risks connected to exploitation are then mapped and prioritised.

The ESS provides the participants with the opportunity to work on:

1) the identification/grouping of key exploitable results;
2) the first definition of the related exploitation strategy;
3) the identification and mapping of risks related to the exploitation;
4) follow-up actions.

2.2 DEFINITIONS

Results: Any tangible or intangible output of the action, such as device, data, knowledge and information whatever their form or nature, whether or not they can be protected.
Communication: the **promotion of the project and its results** to a multitude audience (including the media and the public/society) in a strategic and effective manner.
Dissemination: the **public disclosure of the results** by any appropriate means (other than resulting from protecting or exploiting the results), including by scientific publications in any medium.
Exploitation: the **utilisation of results** – up to four years after the action:

- in further research activities other than those covered by the action concerned, or
- in developing, creating and marketing a product or process, or
- in creating and providing a service, or in standardisation activities.

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2.3 CHARACTERISATION TABLE

The characterisation table is the tool used in the ESS to summarise the main features of a KER and to provide information on the selected exploitation route. Information summarised in the characterisation table is to be further integrated and finalised after the ESS, and used as input for the Plan for exploitation and dissemination of the results (PEDR) and business plan for the exploitable result. It does not focus on the scientific dimension of the KER but offers a snapshot of the most important elements to be considered when dealing with the use of a result, following a problem oriented (demand driven) approach.

During the ESS project partners have discussed the characterisation table in an interactive manner and further finalised it.

In the table, each element is described in a simple way highlighting the most important features that distinguish the result from current solutions. The table contains information on:

- **The novel solution:** Description of the Result, problem solved, Unique Selling Point (competitive advantages or innovativeness introduced compared to already existing Products/Services,);
- **Market:** Product/Service Market Size, Market Trends/Public Acceptance, Product/Service Positioning; Competitors/Incumbents, Prospects/Customers;
- **External factors:** Legal or normative or ethical requirements (need for authorisations, compliance to standards, norms, etc.);
- **Go to market aspects:** Cost of Implementation (before Exploitation), Time to market, Estimated Product/Service Price, Adequateness of Consortium Staff, External Experts/Partners to be involved;
- **IPR Status*:*** Background (type and partner owner), Foreground (type and **partner owner**);
- **Exploitation Strategy:** Exploitation Forms (direct industrial use, technology transfer, license agreement, publications, standards, etc.), Which partner contributes to what (main contributions in terms of know-how, patents, etc.) Partner/s' expectations, Sources of financing foreseen after the end of the project (venture capital, loans, other grants, etc.).

2.4 PRIORITY MAP AND RISK MATRIX

The Priority Map provides at a glance a snapshot on the main risks identified by the partners. It is based on risks selected in the Risk Matrix assessment tool and the proposed remedy actions. The Risk Matrix helps the partnership identifying for each KER, the type of risk, its level of importance related to the use of the concerned KER, the probability for such a risk to happen, remedy actions and their probability to succeed.

The Risk Matrix analyses the following six different categories of risks:

- **1. Partnership Risks:** internal risk factors related to the composition of the partnership or specific behaviours of the partners, conflict of interests, etc.
- **2. Technological Risks:** external factors related to the feasibility of the technology, its level of development, presence of other emerging technologies, etc.

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- **3. Market Risks:** external risk factors related to fulfilment of marked needs, presence of competitors or alternative products, etc.
- **4. IPR Risks:** factors related to the presence of similar previous patents, the possibility to protect the developed technology/product, patent counterfeit, etc.
- **5. Environmental risk factors:** are external factors related to the presence or changing in legislations, standards, etc. Special attention will be given to regulatory environment and standardisation issues.
- **6. Financial risk factors:** factors related to the availability of funds for bringing the research stage to prototyping industrialisation/commercialisation.

The severity grade is scored for each risk (1 = low; 10 = high). The grade shows the importance of the risk with respect to successful exploitation. For example:

- a previous patent, on the same technology, is a severe risk (10 points) if our exploitation route is fully relying on patenting;
- the sudden change of market conditions can be a severe risk if we want to introduce a product into the market.

After scoring the severity grade, the second step is to evaluate the probability for the risk to happen (1 = low; 10 = high). In the examples above:

- in the case of the patent, if we realize (after a quick search) that there is a patent preventing us to patent as well, then the probability of happening is 100% and the related mark is 10;
- in the case of market change: the apple market will not change so dramatically in the next future (grade 1) while apps market is changing every day (grade10).

The product of the severity and the probability grade will give the risk grade of the concerned risk factor (value on the x axis).

The risk grade coupled with the probability of success will position the risk in the Priority Map.

- A high-risk grade and a low probability of success of the intervention, identifies a situation where we may consider discussing to stop the project (Warning). Examples:
  - There is a patent interfering with the one we would like to file. As a remedy, there is the plan to ask the owner for an agreement but, it is evident, chances of succeeding are very low. The selected exploitation path is blocked and there is not any possibility to go on;
  - The market is changing regulations and the product is not compliant anymore. As a remedy, there is the re-design of the product but with a very low probability of having something that will match the customers' needs. This may lead to the decision to stop the project.

- A high-risk grade with a high probability of success for the remedy action defines a situation where there is the need for an immediate action to ensure exploitation (action). Examples:

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  - There is a previous patent interfering with the one we are about to file in. An agreement with the previous patent is feasible. In this case, the exploitation of that technology, if the agreement is reached, it is still possible, but action should be taken as soon as possible;
  - The market is changing regulations and the product is not respecting the new one. The re-design of some components will fulfil both compliance to new regulations and customers' needs. Partnership should re-think our project as soon as possible.

- A low-risk grade coupled with a high probability of success of the planned remedy defines a situation where it would be preferable to keep an eye on what is happening (Control) to be ready to act. Example:
  - Regulations in the market have not changed since the last 20 years and our product is valid only with such regulations. As a remedy, we should re-design some components to continue to be on the market. We have to monitor the situation (regulatory framework) and in case it will change, we have to immediately re-design our product.

- A low-risk grade and a low probability of success for the remedy, it is a situation does not call for immediate action (no action). Examples:
  - Regulations in the market have not changed since the last 20 years and our product is valid only with such regulations. We could think to re-design our product but there are low possibilities to get good results. Under these conditions it is better not consider any intervention;
  - Regulations in the market have not changed since the last 30 years and our product is fully compliant. There is no need at the current stage to modify our product nor to be worried about any change in regulations.

2.5 DEVELOPING AN EXPLOITATION PLAN

The ESS is just one of the first steps of a structured path towards exploitation. Working with KERs calls for understanding what the actual results are (or will be) and what needs to be done by the end of a project (and beyond) to have a clear and actionable exploitation plan ready and agreed among partners.
In the following pages, tables are provided that illustrate how and what needs to be discussed during the ESS, in order to develop and prepare an Exploitation Plan. Using these tables will help project partners to better prepare and structuring the Plan for Exploitation and Dissemination of the Results by focusing on relevant information planning actions and ensuring resources needed for a sustainable use of the results. Support in finalising is part of the Business Plan Development service provided by SSERR[4].

[4] A service aiming to deliver a snapshot of the main fields from the competition and the business model envisaged to the early adopters and market approach. Additionally, it provides an exploitation roadmap and a budget estimation for the first months after the project's end. It can be requested by eligible projects, even if they already got an ESS.

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KER Table[5]

KER name	
Problem	*Describe the problem you are addressing (the problem your "customer" has).* *"Customer" is meant here the people, companies, organisations, etc. who will use the result.*
Alternative solution	*Describe how your "customer" has solved the problem so far.*
Unique Selling Point (USP) - Unique Value Proposition (UVP)	*Describe the competitive advantages, innovative aspects. What does your solution well, what are the benefits, what does the user/customer want, how does your solution solve his/her problem, what distinguishes it from the competition / current solutions?*
Description	*Describe in a few lines your result and/or solution (i.e. product, service, process, standard, course, policy recommendation, publication, …)*
"Market" – *Target market*	*Describe the market in which your product/service will be used/can "compete", answering the following questions:* *- What is the target market?* *- Who are the customer segments?* *- Who might be the early adopter (those you might address first)?*
"Market" - Competitors	*Who are your "competitors" (note: they are the ones offering "alternative solutions")?* *What are their strengths and weaknesses comparing to you?*
"Market" - Size Not to be filled in in the ESS	*What is the market size for your solution?* *What is the percentage of that market you will be targeting?* *If you are dealing with training, provide information on the size of potential beneficiaries. If you deal with policy recommendations provide an estimation of how many people/SMEs will be affected.* *Feel free to propose other ways for an estimation of the size of the impact.*
"Market" - Trends Not to be filled in in the ESS	What are the market trends related to your solution?
Settings Not to be filled in in the ESS	*What is the public acceptance?* *What is the social impact?* *What is the environmental impact?* *What is the economic impact?*
Settings Not to be filled in in the ESS	*What are the legal requirements?* *What are the normative requirements?* *What are the ethical requirements?*
Go to Market – Use model Discussion to be started at the ESS	*Explain what is your "business model", how the KER will be put in use (made available to "customers" to generate an impact). Examples of use models: manufacturing of a new product, provision of a service, direct industrial use, technology transfer, license agreement, contract research, publications, standards, etc.* *Note training is a service.*

[5] White sections to be filled by beneficiaries during the ESS and reviewed / updated for the final report / PEDR, grey sections to be filled in for the final report / PEDR

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Go to Market – IPR Discussion to be started at the ESS	*What is the Background (type/ partner)?* *Provide information considering also what already agreed in the Consortium Agreement.*
Go to Market – IPR Discussion to be started at the ESS	*What is the Foreground (type/ partner)?* *Provide information considering also what already agreed in the Consortium Agreement.*
Go to Market Discussion to be started at the ESS	*What is the time to market?*
Go to Market Not to be filled in in the ESS	*How will you reach the Early Adopters?*
Go to Market Not to be filled in in the ESS	*What will be the eventual price of the solution?* *Estimation of price / unit and number of units sold to reach breakeven point (cover costs).*
The Team Not to be filled in in the ESS	*Do you (and your partners) have the adequate skills for providing your solution to the users (to implement the next steps you envisage to put the KER into use).* *Please provide names and qualifications of the team members.* *Please provide a short description of the partner organisation in an annex.*
The Team – External providers Not to be filled in in the ESS	*If you need to integrate your "team, whom do you need (new) external partners? Which type of partners?*

Roadmap

Exploitation roadmap	
Actions	*Briefly describe actions planned 3-6 months after project end.*
Roles	*Roles of partners involved.*
Milestones	*List the milestones and monitoring parameters.*
Impact in 3-year time	Describe impact in terms of growth/benefits for the society *(jobs created, investments mobilized, turnover generated).*
Financials Costs	*Cost estimation to implement planned activities (1 year, 3 years).* *Provide information on the costs/investments needed to bridge the end of the project to the next steps planned (you may invest in a patent, in the realisation of a prototype, etc.).*
Revenues	*Describe, how you will you cover the costs needed to provide it to early adopters, customers and beneficiaries.* *Projected revenues and eventual profits over the next 1-3 years?*
Other sources of coverage	*Financial needs and sources to cover initial budget.* *It should be consistent with the fields above (estimated investment and time to market)* *(e.g. partners` own budget, other project grants, national/regional incentives, risk capital, loans, etc.)*

Use options

KER's Exploitation route (how the KER will be further exploited)

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Note: only one option is to be selected			
Selected route		**Implementing actor**	**Yes**
DIRECT USE	Commercialisation: *deployment of a novel product/service (offered to the target markets)*	One partner	
		A group of partners	
	Contract research (*new contracts signed by the research group with external clients*)	A partner	
		A group of partners	
	A new research project (*application to public funded research programmes*)	A partner	
		A group of partners	
	Implementation of a new university - course (*Note that a training course is a service*)	A partner	
		A group of partners	
		A new partnership	
INDIRECT USE	Assignment of the IPR	A partner	
		A group of partners	
	Licensing of the IPR	A partner	
		A group of partners	
	Development of a new legislation/standard	A partner	
		A group of partners	
	Spin- off	A partner	
		A group of partners	
		By assignment	
		By licensing	
	Other (*please describe*)		

Further recommendations for the use of the ESS framework are provided in the Annex.

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3 KEY EXPLOITABLE RESULTS

This chapter is the heart of the report and provides a set of 37 KERs outlined by each of the individual project beneficiaries. It consists of even so many subsections, per KER each addressing:

1. Characterization of the result
2. Exploitation Roadmap
3. Risk Matrix

as explained in the beforementioned chapter 2.

Some beneficiaries have been working on more than one KER and their outcomes have been included. Per KER the type of exploitation is given, see table below.

SHORT NAME	KER #	TYPE OF EXPLOITATION
DNV GL	1	Service
KEMA	2	Service
ABB	3	Product
KU Leuven	4-7	Service Development of a new standard Further research/Education
KTH	8	Product/further research
EirGrid	9	Increased knowledge
SGI	10-12	Products/Services/Further contract research
DWG	13	Service
MEU	14-15	Products
Svk	16	Increased knowledge
GE[6]	--	n.a
UniAbdn	17	Patent
RTE	18	Development of a new standard
TU Delft	19	Services
Equinor	20	Increased knowledge
TenneT[7]	--	n.a.
SOW	21	Consultancy services
Siemens	22	Increased knowledge
DTU	23	Service
RWTH Aachen	24	Service
UPV	25	Contract research

[6] Given the very limited role in PROMOTION, GE Grid Solutions doesn't see a possibility to exploit any KER from the project. However, GE Grid Solutions will consider the outcomes of PROMOTION in its strategic planning activities

[7] TenneT's KERs are an integrated part of the project's deliverables (refer to D12.4: 'Final deployment plan for future European offshore grid development'). TenneT's comprehensive efforts in WP12 can be characterized as predominantly exploitation of the project results. There is no way back for the TSO (after project end) in its concrete efforts in the development of offshore HVDC in the Northern Seas.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.

FGH	26	Product/Service - Software
Ørsted	27	Development of a new Standard
Carbon Trust	28	Consultancy services
Tractebel	29	Consultancy services
EUI	30	Policy recommendation
T&D Europe	31	Increased knowledge and competence
USTRAT	32	Service
Prysmian	--	n.a
RUG	33	Policy recommendation
MVOW	34	Development of a new standard
Energinet	35	Increased knowledge – CBA methodology
SHE Transmission	36	Modelling services
SCiBreak	37	Product

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3.1 **KER NO.1** - CONSULTING SERVICES RELATED TO SOCIETAL CBA FRAMEWORK FOR MESHED OFFSHORE GRIDS

KER Leading Partner: DNV GL

3.1.1 CHARACTERIZATION OF THE RESULT

DNV GL: Societal Cost-Benefit Analysis framework for meshed offshore grids	
Problem	DNV GL's customers often seek support in conducting Cost Benefit Analysis (CBA) of complex energy infrastructure projects, such as transmission power networks. The difficulty of such an analysis lies in the fact that transmission networks, in particularly the ones located offshore, are vital component of national energy system that requires technical feasibility but also economically effective design where benefits to society will outweigh the high costs of upfront investment which are inherent in infrastructure projects. DNV GL supports its customers in conducting a cost-benefit analysis of (offshore) transmission networks using the framework that has been developed in the course of PROMOtioN project Work Package 7.
Alternative solution	So far, the cost-benefit analysis of transmission infrastructure had mainly project or national perspective, failing to adress effects of system integration and wider impacts on adjacent networks of neighbouring countries. Furthermore, current CBA practices are not tailored to the analysis of dual-use infrastructure such as hybrid offshore assets used both for energy evacuation and trading.
Unique Selling Point USP - Unique Value Proposition UVP	DNV GL has developed a societal CBA framework which is based upon ENTSO-E guideline for CBA, however, is tailored specifically to offshore network projects, including meshed or integrated grid solutions. At the current moment there is little to no experience with analysing such projects and quantifying as many key performance indicators of such projects as possible. Hence, having in-house framework designed to adress specific needs of offshore grid deployment will have DNV GL to further boost it engagement with its clients, including governments, regulators, TSOs and wind developers.
Description	Developed CBA methodology consists of the definition of KPIs for the assessment, potential of their monetization in the ideal and practical case, assessment framework, decision-making framework, guidelines on scenario and counterfactual case determination.
"Market" – *Target market* (Customers)	Potential customers include European TSOs, infrastructure developers, offshore wind developers, national planning agencies, regulators, industry bodies, ministries and project financers.
Early Adopters	European TSOs, developers and and relevant European government bodies
"Market" - Competitors	Competitors include other engineering consultancy companies across European markets. Our strength is in our global presence, technical legacy, synergies between different business areas which allow to e.g. apply knowledge from renewables and market advisory for advising in grid development. Our strength is in our independence and trust that we have deserved among our clients through high level services we provide. By advising wide range of clients we capitalize on combined knowledge and apply expertie from adjacent industry areas to adress clients' demand from the ysstem perspective. Competitors may be stronger in strategic and financial advise.

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Go to Market – Use model	Two ways of using the developed framework are: 1) Selling the framework tailored to client's needs as a decision-making framework for their investment. This needs to be supported with educating clients on its use and ap plication, explaining the reasonning and approach to KPI assessment, scenario and assumptions, etc. 2) Applying the framework to conduct a CBA for clients. DNV GL has been and is actively supporting its clients when it comes to assessing their investment plans or optimizing transmissin infrastructure roll-out.
Go to Market – IPR	n.a.
Go to Market – IPR	n.a.
Go to Market	Instant, it is expected that with the increasing awareness of coordinated offshore grid development the demand for tailored CBA framework will grow rapidly. In fact, we already see clients approaching us with this type of requests.

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KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	X	
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner		
		A group of partners		
	A new research project (application to public funded research programmes)	A partner		
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

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3.1.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	1) Market research identifying potential customers interested in societal cost-benefit analysis of electricity transmission infrastructure. 2) Follow up with such customers explaining the novelty of the developed framework and its utility. 3) Internal dissimination nd education within DNV GL to apply developed principles in already running projects and ongoing bids. 4) Development of easy-to-use internal tools and models for future application based on the developed framework.
Roles	DNV GL - main role in framework utilization. DNV GL clients - benefit from the service that DNV GL will provide.
Milestones	1)Use the fact that the CBA framework was developed by DNV GL to showcase our expertise to potential clients. Make them aware of our new capability to conduct CBA of their projects. 2) First application of the new framework in a commecrcial project. 3)Permanent use of the framework in commercial projects with further improvements and case tailoring.
Impact in 3-years time	It is expected that with the roll-out of offshore infrastructure and increasing activity around further transmission network optimization in order to accomodate increasing amount of renewables there will be more and more use cases and potential project to apply the framework. It is expected that having such a framework in-house will allow DNV GL to increase its order intake and increase quality of services delivered.
Financial costs	No costs envisaged
Revenues	Depending on the complexity of clients'projects, required analysis, industry developments, consultancy market developments revenues may vary.
other sources of coverage	It is expected that utilising the framework for commercial projects will be the main osurce of revenue and coverage.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.

3.1.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***0***	***1***			***5***	
	Disagreement on ownership rules	*0*	*0*		Legal mediation of downership disputes and patent review	*0*	
	Industrialization at risk: a partner declares bankruptcy.	*0*	*1*	**0,0**	initiate consortium meeting toexplain usage issues and redefine roadmap of exploitation	*8*	**0,0**
	Industrialization at risk: a partner declares bankruptcy.	*0*	*1*		maintain communication with exiting expert and organise hand-over and training	*8*	
2	**Technological Risk Factors**	***8***	***6***			***8***	
	better technology emerges	*6*	*6*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*8*	
	limited market (flow limitations)	*10*	*5*	**44,0**	redesign of valve configuration to enhance range of device		**352,0**
					correctly assess existing market technologies and assess performance and ability to penetrate market through replacement in exisiting applications		
3	**Market Risk Factors**	***8***	***3***			***4***	
	Exploitation disagreement	*8*	*1*		discuss exploitation proposals and ensure that parappel exploitation is beneficial and in the interest of marketing the trechnology	*3*	
	difficulty in market penetration/customer reception and acceptance of technology	*8*	*4*	**20,0**	additional market studies, customer surveys and assessment of product shortfalls	*5*	**80,0**

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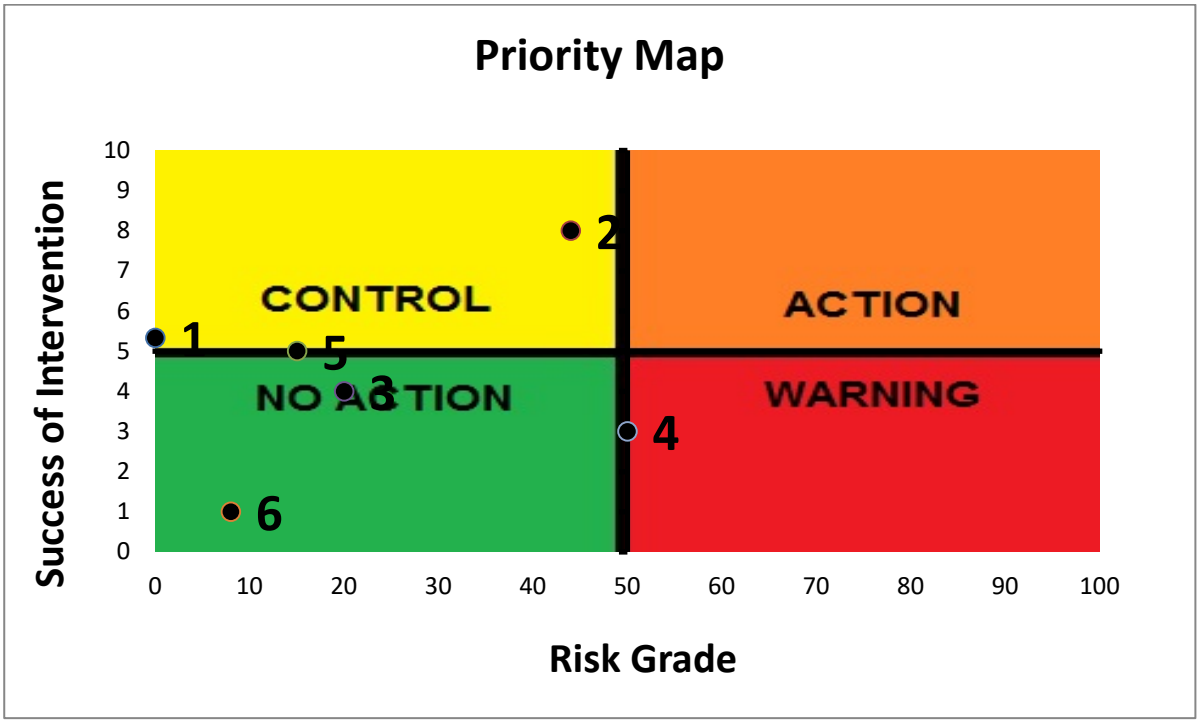
4	**IPR/legal Risk Factors**	***5***	***10***	**50,0**		***3***	**150,0**
	competitors replicate technology	*5*	*10*		stricter control in in patent usage and aggressive pursuit of legal action	*3*	
5	**Financial/management Risk Factors**	***3***	***5***	**15,0**		***5***	**75,0**
	weak exploitation of the material	*3*	*5*		revision of exploitation plan and market research and relaunch of product	*5*	
6	**Environmental/regulatory Risk Factors**	***8***	***1***	**8,0**		***1***	**8,0**
	not in compliance with regulations	*8*	*1*		assessment of legal/regulatory requirements and alteration of product to comply	*1*	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

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3.2 **KER NO.2** - FULL-POWER TESTING OF HVDC CIRCUIT BREAKERS FOR HVDC GRIDS

KER Leading Partner: KEMA Labs (former part of the DNV GL Group)

3.2.1 CHARACTERIZATION OF THE RESULT

Full-power testing of HVDC circuit breakers for HVDC grids	
Problem	There is almost no experience with HVDC circuit breakers: they are new products in the market and have only been tested and applied on a very limited scale in China. HVDC breakers combine a number of new technologies that cannot be verified efficiently in a complete product. Testing of HVDC circuit breakers requires a very large power to demonstrate their correct functioning. System requirements are not clearly defined. Specification of HVDC circuit breaker does not exist. There is an absence of standards in accordance to test with: test requirements do not exist.
Alternative solution	Testing of modules of HVDC circuit breakers, testing of subcomponents, testing of reduced size industrial prototypes. Testing at reduced power, voltage and/or current and energy. No physical testing: paper review; design review based on design information only augmented with calculations/modelling. Use of project specific requirements in stead of standards.
Unique Selling Point USP - Unique Value Proposition UVP	Use of existing test-installations at test facilities, designed for HVAC circuit breakers to be adapted for use for HVDC circuit breakers. Competive advantage is the availabilty of a test method that includes all parts of the critical (fault current interruption) process. The innovative aspect is the application of a low power frequency, to create a window of opportunity for verification of all relevant process.
Description	The product to the market consists of a service, infrastructure and intelligence to test HVDC circuit breakers up to 350 kV, 25 kA. The unique selling point, acquired through PROMOTioN is the capability to verify all the essential steps in the fault removal procedure in a single test circuit. Test requirements, that have been defined in PROMOTioN are agreed among the HVDC circuit breaker manufacturers. Having these requirements (ahead of standards) and the demonstrated tests as a reference makes KEMA Labs leader in the world in HVDC circuit breaker testing.
"Market" – *Target market* (Customers)	The potential users of HVDC circuit breakers (TSOs) that now can ask for independent equipment test certificates as part of their Q&A process. Direct customers are equipment manufacturers (OEMs) that wish to gain preferred access to the market (potential users) to have independent verification of their products. OEMs that ask for product development testing (maybe partial, unit-wise) because they lack test/R&D facilities or own it but at insufficient power. OEMs that wish to test related equipment (HVDC transfer switches, MVDC switchgear, ultra-fast acting fault current limiters etc.). OEMs who wish to gain benefit from our expertise gained by the project.

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Early Adopters	Those OEMs who wish to demonstrate that they have independently tested products avialable at some level of power, in order to increase acceptance in the competitive market. Start-ups and SME's that do not yet have a well-established name in industry.
"Market" - Competitors	Those who offer incomplete solutions, by carrying out testing under unrealistic stresses. Or by partially testing with misconception that independently tested subcompnents can work as expected when assembled together. Consultants who witness incomplete tests or perform design review. Modelling of stress-withstand using inadequate models.
Go to Market – Use model	The market is limited and our test facility is recognized all over the world. Business model is based on visibility of the level we reached in testing resources, both materially and with human capital. Visibility is gained by appearances in the relevant conferences, symposia, panels, committees, working groups in the industry (CIGRE, IEC, IEEE). Supported by well-documented research papers, white-, review and position papers underpinning the thought- leadership in this aspect of technology. Company-to-company visits explaining the expertise and possibility to exchange, transfer. Inclusion of insights, expertise gained in professional trainings for the industry. Exchange information with consultants on major projects in the world. Higher prices are justified by added value of additional information (gained through dedicated measurements) allowing detailed analysis of relevant processes. Sharing information on standardization status by participating in relevant bodies. Awareness of standards, regulations, literature before publication.
Go to Market – IPR	IP of testing technology - not laid down in patented information. Detailed information on electrical and physical processes during relevant processes, well described in technical literature.
Go to Market – IPR	Huge learning curve, went through by testing and observing the novel OEM's technologies. Various phenomena observed, studied and analyzed that is only revealed during the testing of real products and investigated in detail in experimental test-objects, results and lessons learned are shared in the project. Added value beyond simulation, which is on ideal object only. Mostly proprietary information of project partners, classified in the project.
Go to Market	Ready to offer test- and analysis technology now. HVDC grid market in Europe is delaying with respect to original expectations at the start of the project. Chinese market difficult to access because of "Chinese only" policy at local TSOs

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.

KER's Exploitation Form					remarks
Selected route		**Implementing actor**	**Yes**	**No**	
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		x	
		A group of partners	x		Testing service now offered to the global market
	Contract research (new contracts signed by the research group with external clients)	A partner	x		Possible bi-lateral R&D research offering to industrial customers
		A group of partners		x	
	A new research project (application to public funded research programmes)	A partner		x	Not planned
		A group of partners		x	
	Implementation of a new university - course (Note that a training course is a service)	A partner	x		Results are implemented in existing training course / workshops
		A group of partners		x	
		A new partnership		x	
INDIRECT USE	Transfer of ownership (IPR)	A partner		x	
		A group of partners		x	
	Licensing IPR	A partner		x	
		A group of partners		x	
	Development of a new legislation/standard	A partner		x	
		A group of partners	x		Results and new insight are being brought to international standardization of IEC
	Spin- off	A partner		x	
		A group of partners	x		Testing services of HVDC switchgear (not related to HVDC grids) are being marketed
		By assignment		x	
		By licensing		x	
	Other (please describe)		x		Visibility, exposure for thought leadership in this field

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3.2.2 EXPLOITATION ROADMAP

Exploitation roadmap	
Actions	We will continue to give international exposure to the results obtained and start actions to incorporate testing of other HVDC switchgear in our services portfolio. HVDC switchgear is used in all HVDC projects, not exclusively in HVDC grids. As such, this PROMOTioN spin-off could potentially cover the uncertainty in market for HVDC circuit breaker testing due to lack of HVDC grid plans on short, mid-term
Roles	None, everybody goes his own way. We keep being aware of eachother's capability in future commercial testing of HVDC switchgear/breakers.
Milestones	We will use our standard methods/KPIs in measuring progress in our innovation activities, business development and international exposure. These KPIs are: • The number of international presentations on the newly acquired test methods, • Sales of testing services directly and indirectly related to HVDC breakers, • Number of RfQs (request for quotations) received and other sales indicators. Indirect spin-off is difficult to quantify. The access to testing services for related equipment (eg superconducting fault current limiters) is increased having a record of HVDC breaker testing.
Impact in 3-years time	This workpackage's societal impact is boosting and saveguarding the European capability of manufacturing and testing key equipment for future infrastructure and bringing it to full demonstration level. We expect testing of one HVDC switchgear per half year. High-volume sales of HVDC breakers is not foreseen, giving the delay in a North Sea grid development plan, but expansion of services is foreseen in the HVDC switchgear market (switchgear other than HVDC circuit breakers) and in related equipment, eg. fault current limiters. Commercial spin-off already started since a PROMOTioN partner has ordered commercial testing (outside PROMOTioN) on its HVDC breaker in 2020. This will generate around 200 kE of revenue per year. No extra jobs foreseen in our organization.
Financial costs	The costs, necessary to adopt HVDC switchgear testing into our testing activities will be covered from our innovation budget. At first, we wish to set up a demo of HVDC transfer switch testing, which will require around 50 kE of budget for laboratory capacity. We will disseminate the results of that demo and include this in our regular BD and sales activities, which is at no extra costs We are in search for a launching customer.
Revenues	There are no additional costs for this. During the project, after the various testing, exposure was given to the new service capabilities. In itself, the service is ready now to be adapted by the market. Problem is the lack of market, in this case the absence of plan to realize a HVDC grid in Europe, which brings hesitations to invest beyond what was already done for PROMOTioN. There are however plans for two major product demonstrations in 2020. In trainings and dedicated BD actions in 2020 for Asia the newly acquired testing services will be embedded. Related projects (superconducting current limiter) will be also be presented through our international sales and BD network. The PROMOTioN workshop at CIGRE conference (Aug. 26) will be a major promotional channel to highlight the testing records achieved (if it will still be organized). Such sales/BD expenses will be in the order of 10 k€.
other sources of coverage	Time to market for the service developed in PROMOTioN is zero, the service is available. The spin-off, HVDC switchgear testing (applicable to equipment in all HVDC projects) will be incorporated in our innovation strategy, to be finalized after KEMA's acquisition by its new owner.

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3.2.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***2***	***3***	**5,6**		***8***	**44,4**
	Industrialization at risk: no manufacturer for the exploitable result.	*1*	*2*		Legal mediation of downership disputes and patent review	*8*	
	Industrialization at risk: a partner declares bankruptcy.	*2*	*4*		initiate consortium meeting toexplain usage issues and redefine roadmap of exploitation	*8*	
	Industrialization at risk: an business partner leaves the market.	*2*	*4*		maintain communication with exiting expert and organise hand-over and training	*8*	
2	**Technological Risk Factors**	***4***	***7***	**28,0**		***8***	**210,0**
	Worthless result: better technology/methodology exists.	*5*	*6*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*8*	
	limited market (flow limitations)	*3*	*8*		change to another market	*7*	
3	**Market Risk Factors**	***4***	***8***	**30,0**		***6***	**165,0**
	Nobody buys the product. Nobody needs it.	*3*	*8*		change to another related market	*5*	
	difficulty in market penetration/customer reception and acceptance of technology	*5*	*7*		Starting awareness process of end-customer	*6*	
4	**IPR/legal Risk Factors**	***6***	***7***	**42,0**		***5***	**210,0**
	competitors replicate technology	*6*	*7*		Promotion technical superiority of actual test method	*5*	

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5	**Financial/management Risk Factors**	***5***	***4***	**15,8**		***7***	**110,3**
	Inadequate communication among partners.	*3*	*4*		Advertising of service through relevant international professional channels	*7*	
	Lack of endorsement from top management	*6*	*3*		Support by market parties	*7*	
6	**Environmental/regulatory Risk Factors**	***1***	***1***	**1,0**		***8***	**8,0**
	not in compliance with regulations	*1*	*1*		standardization to support acceptance of service	*8*	

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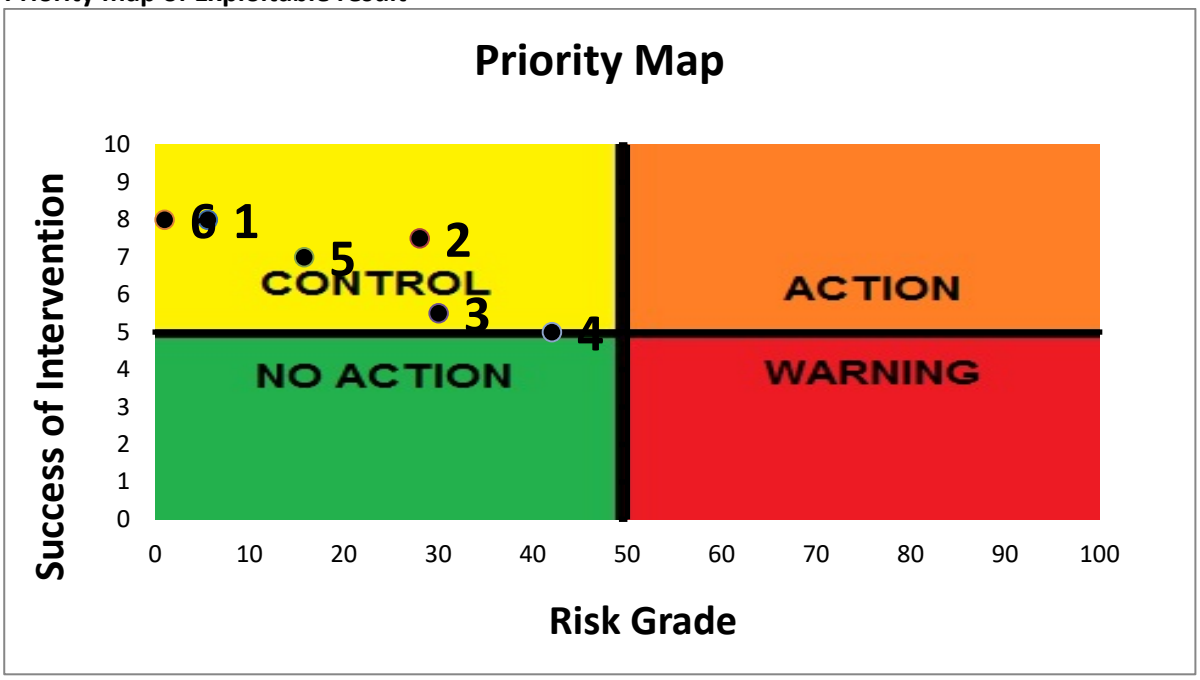
Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Partnership and Technological risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act. The Partnership risks should maintain a communication with exiting expert and organised a hand over and training. Considering the Technological risk factors the technology should be re-evaluated and further optimised to match/outperform new benchmark.

Considering Market, IPR/legal, Financial/Management and Environmental risk factors have been registered a low-risk grade and a low probability of success for the remedy, this situation does not call for immediate action.

3.3 **KER NO.3** - HIGH VOLTAGE DIRECT CURRENT GAS-INSULATED SWITCHGEAR

Leading partner: ABB

3.3.1 CHARACTERIZATION OF THE RESULT

High Voltage Direct Current (HVDC) Gas-Insulated Switchgear (GIS)	
Problem	The problem is to connect HVDC equipment in a HVDC system/grid. Isolation of HV systems require large clearances between high voltage parts and grounded elements and therefore require 3 to 10 times larger space (land or space on off-shore platforms) than necessary with AC systems. All HVDC systems face this problem.
Alternative solution	DC installations are executed with air-insulated switchgear (AIS). AIS equipment is consuming large space and is exposed to ambient conditions. Especially for offshore converter platforms, the required air-clearance for AIS leads to large and heavy offshore structures that come at high cost.
Unique Selling Point USP - Unique Value Proposition UVP	A DC-GIS installation can be built with a much higher degree of compactness and significantly lower sensitivity to ambient factors than with air-insulated switchgear (AIS). The most obvious cost-saving potential can be found on off-shore converter platforms where the required air-clearance for AIS leads to much larger and heavier off-shore structures. By using DC GIS, the volumetric space of the switchgear installation can be drastically reduced e.g. by 70%- 90%. Long-term dielectric operation has been demonstrated successfully in a unique long-term test at an independent 3rd party lab.
Description	In order to connect HVDC equipment (e.g. lines, cables, converters, etc.) following **HVDC-GIS** switchgear components have been developed and long-term tested: • Bus-ducts and high voltage DC conductors; • Disconnect- and earthing switches; • Bushings and cable terminations; • Current- and voltage measurement sensors; • Surge arresters. These modules have been part of the long-term tests performed at KEMA in the PROMOTioN project. The tests showed that these modules can facilitate the possible space reduction mentioned above.
"Market" – *Target market* (Customers)	This is a typical B2B environment. The **GIS** will be supplied to an EPC who does the electrical system integration (only exception is China). Target markets are: - Off-shore HVDC stations (EPCs); - On-shore HVDC stations (EPCs); - Cable transition stations (EPCs, Utilities (e.g. TenneT); - DC GIS connections - potential uncertain. These are target customers as they will save huge amounts of space and costs employing our HVDC GIS solution. It is however difficult to assess the potential dimension and size of each market as it relies on a number of unclear factors connected to the future development of the electricity market .

Early Adopters	Basis is to bundle HVDC GIS solution within own projects provided as EPC. Early adopters are assumed to be for offshore projects because space and protection against environment are most beneficial/economical. Early adopters are expected to be in Northern Europe. .
"Market" - Competitors	• Siemens (Pilot: Dolwin6 Offshore) 320kV ready, 550kV close to be ready. Strengths: Pilots won, Strong Technology, German Company. Weakness: No comparable third-party long-term test. • GE development started, first publications. Strengths: - Weakness: No product available. • Mitsubishi 550kV product ready. Strengths: 550 kV product ready. Weakness: usually very robust but high cost product.
Go to Market – Use model	The HVDC GIS will be sold and delivered as a physical product in a subsystem including HVDC GIS related engineering. First: Prepare the market: Publish test results from PROMOTioN to increase customer confidence. Actively address potential customers and promote value proposition. Support standardization of HVDC GIS to provide de-risking to end-customers. Second: Offer HVDC GIS for coming projects together with ABB as EPC. Pricing: To be based on customer value - value may be higher for off-shore projects. However, need to be balanced with execution risks, which might be higher as well.
Go to Market – Background IPR	According Consortium Agreement HVDC GIS design is owned by ABB and can be exploited without restrictions.
Go to Market – Foreground IPR	With respect to exploitation of the test results there is no issue identified from co-creation or co-ownership.
Go to Market	Preparation of the market can be started immediately after successfully finishing testing. Offering for pilot projects can be started immediately as well. There is no time gap between end of the granting period and the moment the solution can be marketed. Note: Execution of pilot projects may take 1-2 years as per customer timelines.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option) all possible options to be considered are indicated below				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	x	
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner		
		A group of partners		
	A new research project (application to public funded research programmes)	A partner		
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

3.3.2 EXPLOITATION ROADMAP

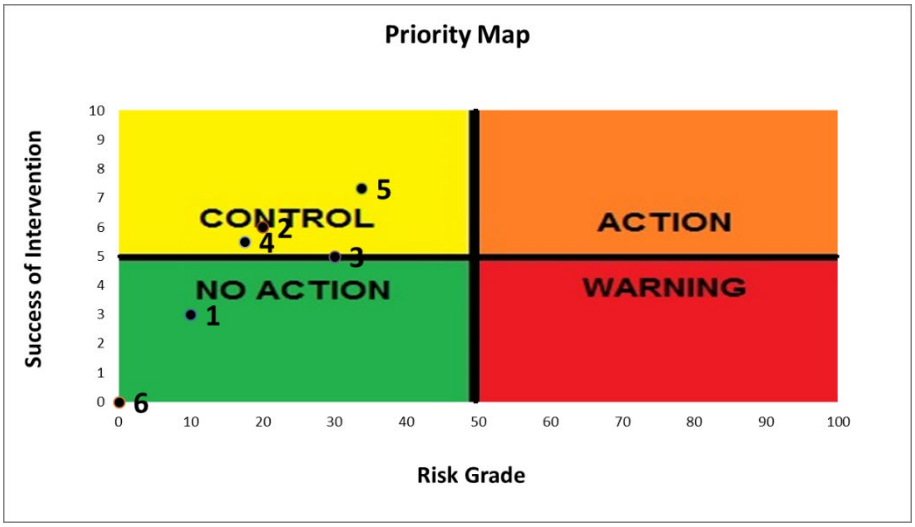
Exploitation Roadmap	
Actions	• Business plan; • Communication among partners 27. Feb .2020; • Marketing to end-customers – CIGRE 2020 (August 2020); • Offering for pilot projects – end 2020; • Execution of pilot projects – end 2022.
Roles	• Partners: ABB PGGI - Facing end user and actively market new solution - providing business intelligence and work-out own business plan. • ABB PGHV - providing technical information to facilitate marketing to end user.
Milestones	• Business plan elaborated. • Communication among partners held - 27. Feb. 2020 (Combined Demo of **HVDC** CB, Arnheim). • End-customer meetings held - CIGRE 2020 (August 2020).
Impact in 3-year time	10 MUSD for **DC GIS** equipment however, impact may be much larger in case it will be a distinctive factor to win or lose a HVDC Project for our Partner.
Financials Costs	Repetition of testing for specific customer homologation/acceptance - 1 MUSD. Until pilot projects - no specific financing needed as resources will be allocated to other projects.
Revenues	• Revenue streams rely on successful execution of project. • For pilot project execution - standard terms and conditions with partial payments based on project milestones.
Other sources of coverage	Pre-financing via own technology company.

3.3.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***10***	***1***	**10,0**		***3***	**30,0**
	Industrialization at risk: an business partner leaves the market.	*10*	*1*		Accept risk until risk happens - then partnership with new partner is an option.	*3*	
2	**Technological Risk Factors**	***5***	***4***	**20,0**		***6***	**120,0**
	Better technology emerges	*5*	*3*		Re-evaluation of technology and further optimisation to match/ outperform new benchmark	*5*	
	Result aiming at replacing existing and well entrenched technologies	*5*	*5*		Long-behaviour testing by accelerated lifetime testing within promotion	*7*	
3	**Market Risk Factors**	***10***	***3***	**30,0**		***5***	**150,0**
	Nobody buys the product. Rejected by end-users.	*10*	*3*		Marketing of advantages of new solution	*5*	
4	**IPR/legal Risk Factors**	***5***	***4***	**17,5**		***6***	**96,3**
	Competitors replicate technology	*5*	*5*		Stricter control in in patent usage and aggressive pursuit of legal action	*5*	
	Legal problems: we are sued for patent infringement.	*5*	*2*		Legal actions to counter and/or strive for license agreement	*6*	
5	**Financial/management Risk Factors**	***6***	***5***	**33,8**		***7***	**247,7**
	Inadequate communication among partners.	*7*	*8*		Adequate communication	*8*	
	Weak exploitation: Inadequate business plan	*4*	*5*		Develop an adequate business plan	*7*	

	No resources (human and/or financial) secured to make the next step toward exploitation	*8*	*3*		Business case given for both partners	*7*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Market risk factors present a situation between Control and No action, where is a low risk grade with a medium probability of success of the planned remedy. A possible type of intervention is to look for new training models and new targets.

The Partnership risk factors present a low-risk grade and a low probability of success for the remedy, it is a situation does not call for immediate action (no action).

The Technological, IPR/legal, Financial/Management present some situations where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act. Considering the Technological Risk Factors a potential intervention could be a long-behaviour testing by accelerated lifetime testing within PROMOTioN. Taking into account IPR/legal risk in order to avoid legal problems, should be taken legal actions to counter and/or strive for license agreement.
In case of Financial/management risk factors, should be developed an adequate business plan.

3.4 **KER NO.4** - SERVICES REGARDING THE DESIGN OF FULLY SELECTIVE VSC-HVDC PROTECTION SYSTEMS

KER Leading Partner: KU Leuven

3.4.1 CHARACTERIZATION OF THE RESULT

Characterization: Design of fully selective VSC-HVDC protection systems and associated pole rebalancing equipment	
Problem	Lack of knowledge/competence regarding the design of protection systems for multiterminal VSC-HVDC systems, potentially leading to suboptimal investments due to hesitance to develop multiterminal systems (of which protection is a pivotal part). Lack of consensus of trade-offs surrounding HVDC protection systems and lack of harmonised terminology and design methodology.
Alternative solution	Not applicable
Unique Selling Point USP - Unique Value Proposition UVP	European competence centre in HVDC protection for multiterminal VSC-HVDC systems, with strong background in design of HVDC protection systems, functional testing of protection IEDs, and associated power system level simulation studies. Standout knowledge in system studies for HVDC protection. Within the PROMOTioN project KU Leuven have developed detailed case studies presenting trade-offs in DC-side protection, in particular focusing on fully selective protection strategies and the associated pole rebalancing equipment that would be required in a symmetrical monopolar system. This high standard work leaves KU Leuven well equipped to perform detailed system studies and provides a strong footing for future industrial research and consultancy projects.
Description	With the background of the extensive work presented by KU Leuven in the PROMOTioN project, we are well placed to offer R&D services regarding HVDC protection. Some examples of specific services that could be offered are: System design studies investigating the equipment required and the trade-offs surrounding HVDC protection on a particular case study system. Consulting on the industrialisation of fully selective HVDC protection strategies, including protection sequences and associated control structures. Evaluation of functional interoperability of HVDC protection concepts or components in a multivendor environment. Open to other propositions for consultancy and industrial research in the field of HVDC protection.
"Market" – *Target market* (Customers)	B2B work. TSOs worldwide. HVDC equipment vendors / component manufacturers. Parties seeking a competent and independent organisation to provide high quality results.
Early Adopters	Progressive European TSOs, for example focusing on offshore wind integration and power hubs. Vendors targeting the first European multiterminal HVDC systems.
"Market" - Competitors	Other research centres and consultants working in the HVDC protection field. For example: State Grid China / GEIRI.
Go to Market – Use model	Provision of consultancy service and or contract research - pricing is based on effort taking into account IP conditions.

Go to Market – IPR	Based on work carried out by KU Leuven within Work Package 4 - e.g. in tasks 4.2 and 4.3 - of the PROMOTioN project, in particular focusing on fully selective HVDC protection strategies, pole rebalancing, multivendor HVDC protection systems, and testing of HVDC protection IEDs.
Go to Market	Directly after the project.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	x	
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner	x	
		A group of partners		
	A new research project (application to public funded research programmes)	A partner		x
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		x
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		x
		A group of partners		
	Licensing IPR	A partner	x	
		A group of partners		
	Development of a new legislation/standard	A partner		x
		A group of partners		
	Spin- off	A partner		x
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

3.4.2 EXPLOITATION ROADMAP

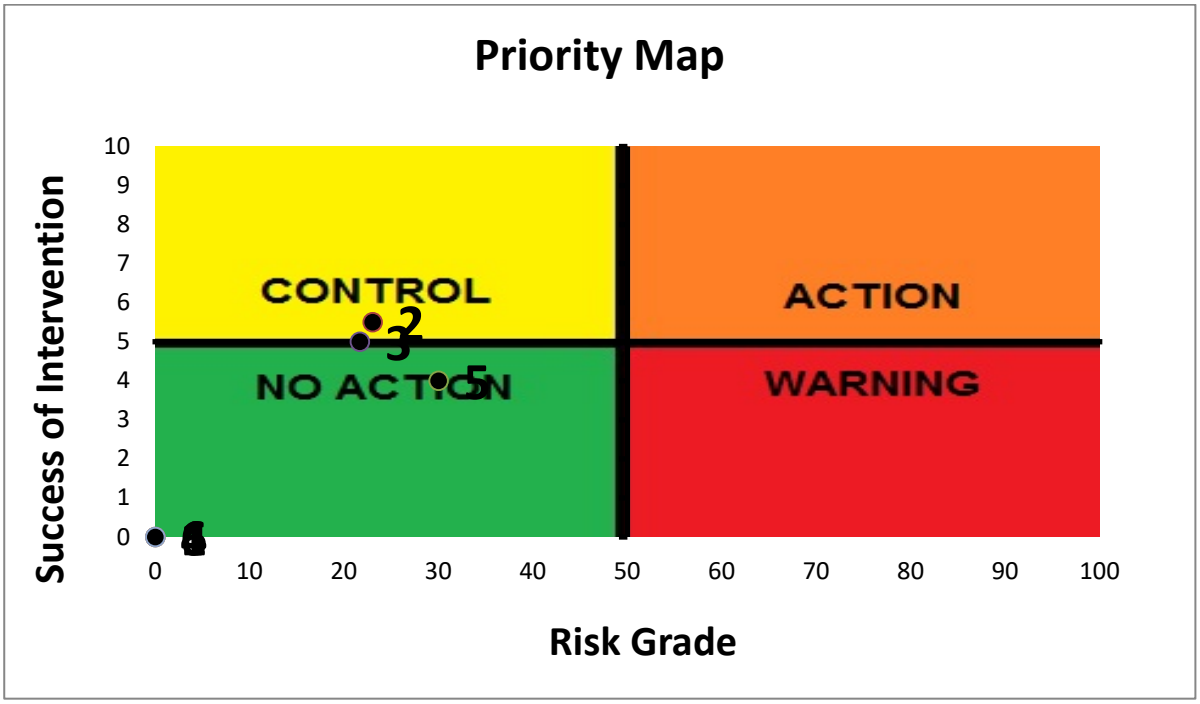
Exploitation Roadmap	
Actions	Announcements and adverts via EnergyVille platforms, industrial fairs, major conferences, …
Roles	Activity only by KUL
Milestones	Announcement, follow-up of feedback
Impact in 3-years time	Aim for influence on decision making and protection solutions for future HVDC projects in Europe.
Financial costs	No upfront investment costs .
Revenues	Operational costs fully covered by consultancy/project.
other sources of coverage	Not applicable

3.4.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
2	**Technological Risk Factors**	***6***	***4***	**23,0**		***6***	**126,5**
	better technology emerges	*5*	*5*		Ongoing research and internal information dissemination to ensure that we remain leaders in HVDC protection know how.	*6*	
	limited market (flow limitations)	*6*	*6*		Being proactive in seeking consultancy work.	*6*	
	Result aiming at replacing existing and well entrenched technologies	*5*	*4*		Continue to make robust technical assessment of existing solutions allowing for strong arguments to be made for new technology solutions.	*4*	
	Worthless result: better technology/methodology exists.	*7*	*1*		Ongoing research and internal information dissemination to ensure that we remain leaders in HVDC protection know how.	*6*	
3	**Market Risk Factors**	***5***	***4***	**21,7**		***5***	**108,3**
	Nobody buys the product. Rejected by end-users.	*4*	*5*		Increase confidence in our research and services by continuing to publish high quality and relevant research.	*6*	
	difficulty in market penetration/customer reception and acceptance of technology	*6*	*5*		Additional market studies, customer surveys and assessment of shortfalls in possible services that we could provide.	*5*	
	Nobody buys the product. The project hits against a monopoly.	*5*	*3*		Further R&D to overcome deficiencies. Improved marketing.	*4*	
5	**Financial/management Risk Factors**	***8***	***4***	**30,0**		***4***	**120,0**
	weak exploitation of the material	*7*	*3*		revision of exploitation plan and market research and aim to promote services in a stronger manner.	*2*	

	No resources (human and/or financial) secured to make the next step toward exploitation	*8*	*5*		Increased development in research group. Presentation of PROMOTioN work to university students which may result in additional human resources becoming available.	*6*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The financial/management risk factor presents a low-risk grade coupled with a high probability of success of the planned remedy.
The identified market risks are on the boundary between no action and control, indicating a low risk and a medium success of possible interventions. There may be benefit to monitoring these aspects in case control action would be benefitial.
The technological risk factor is identified to be low risk but with a reasonable expected success of intervention. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act.
There were no identified factors considering Partnership, IPR/legal and Environmental risks, therefore these aspects require no monitoring or action.

3.5 KER NO.5 - TRAINING IN THE FIELD OF HVDC PROTECTION

KER Leading Partner: KU Leuven

3.5.1 CHARACTERIZATION OF THE RESULT

Training in the field of HVDC protection	
Problem	Lack of knowledge/competence regarding the design and test of protection systems for multiterminal VSC-HVDC systems leading to suboptimal investments due to hesitance to develop multiterminal systems (of which protection is a pivotal part). Lack of high-quality teaching materials and courses regarding state of the art HVDC protection topics. Lack of TSO/vendor in-house knowledge about state of the art HVDC protection.
Alternative solution	Not applicable
Unique Selling Point USP - Unique Value Proposition UVP	European competence centre in HVDC protection for multiterminal VSC-HVDC systems, with strong background in design of HVDC protection systems, functional testing of protection IEDs, and associated power system level simulation studies. Standout knowledge in system studies for HVDC protection. Within the PROMOTioN project KU Leuven have developed detailed case studies presenting trade-offs in DC-side protection, in particular focusing on fully selective protection strategies and the associated pole rebalancing equipment that would be required in a symmetrical monopolar system.
Description	With the background of the extensive work presented by KU Leuven in the PROMOTioN project, we are well placed to offer training and education in the field of HVDC protection. Training could take the form of lectures and workshops, with an intended audience of industrial attendees, in addition to academic researchers and consultants.
"Market" – *Target market* (Customers)	B2B or B2C. TSOs worldwide. HVDC equipment vendors / component manufacturers. Academic institutions starting research on HVDC protection.
Early Adopters	Progressive European TSOs, for example focusing on offshore wind integration and power hubs.
"Market" - Competitors	Other research centres and consultants working in the HVDC protection field. For example: State Grid China / GEIRI. Other leading academic institutions with active research in HVDC protection.
Go to Market – Use model	Training sessions: pricing is based on effort for preparation of materials and course time interaction.
Go to Market – IPR	Work carried out by KU Leuven within Work Package 4 - tasks 4.2 and 4.3 - of the PROMOTioN project, in particular focusing on fully selective HVDC protection strategies, pole rebalancing, multivendor HVDC protection systems, and testing of HVDC protection IEDs.
Go to Market	Directly after the project ends

KER's Exploitation Form

(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	x	
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner		x
		A group of partners		
	A new research project (application to public funded research programmes)	A partner		x
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		x
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		x
		A group of partners		
	Licensing IPR	A partner		x
		A group of partners		
	Development of a new legislation/standard	A partner		x
		A group of partners		
	Spin- off	A partner		x
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

3.5.2 EXPLOITATION ROADMAP

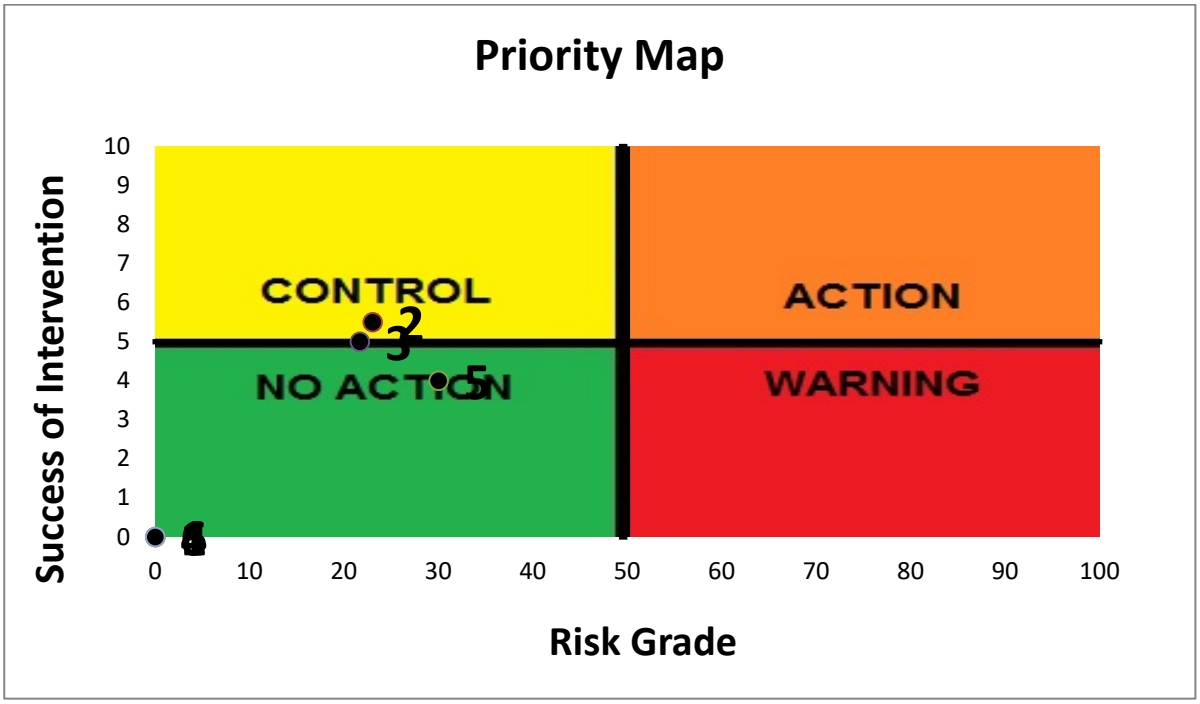
Exploitation Roadmap

Actions	Announcements and adverts via EnergyVille platforms, industrial fairs, major conferences. Discussion of requirements with industrial contacts.
Roles	Activity only by KUL.
Milestones	Announcement and follow-up of feedback
Impact in 3-years time	Aim for multiple training courses provided to international participants from TSOs and/or vendors. Development of PROMOTioN material into academic course content.
Financial costs	No upfront investment costs.
Revenues	Operational costs fully covered by training fees and existing academic teaching budgets.
other sources of coverage	Not applicable.

3.5.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
2	**Technological Risk Factors**	***6***	***4***	**20,6**		***6***	**123.8**
	better technology emerges	*3*	*4*		Ongoing research and internal information dissemination to ensure that we remain leaders in HVDC protection know how.	*7*	
	limited market (flow limitations)	*6*	*6*		Being proactive in seeking customers for training courses.	*7*	
	Result aiming at replacing existing and well entrenched technologies	*6*	*4*		Continue to make robust technical assessment of existing solutions allowing for strong arguments to be made for new technology solutions.	*4*	
	Worthless result: better technology/methodology exists.	*7*	*1*		Ongoing research and internal information dissemination to ensure that we remain leaders in HVDC protection know how.	*6*	
3	**Market Risk Factors**	***5***	***4***	**21,7**		***5***	**108,3**
	difficulty in market penetration/customer reception and acceptance of technology	*6*	*5*		additional market studies, customer surveys and assessment of shortfalls in possible courses that we could provide.	*5*	
	Nobody buys the product. The project hits against a monopoly.	*5*	*3*		Improved marketing. Further development of course material to overcome deficiencies.	*4*	
	Nobody buys the product. Rejected by end-users.	*4*	*5*		Increase confidence in our teaching of state of the art work by continuing to publish high quality and relevant research.	*6*	
5	**Financial/management Risk Factors**	***8***	***4***	**30,0**		***4***	**120,0**
	weak exploitation of the material	*7*	*3*		revision of exploitation plan and market research and aim to promote services in a stronger manner.	*2*	
	No resources (human and/or financial) secured to make the next step toward exploitation	*8*	*5*		Increased development in research group. Presentation of PROMOTioN work to university students which may result in additional human resources becoming available.	*6*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Priority Map for the project

The financial/management risk factor presents a low-risk grade coupled with a high probability of success of the planned remedy.
The identified market risks are on the boundary between no action and control, indicating a low risk and a medium success of possible interventions. There may be benefit to monitoring these aspects in case control action would be benefitial.
The technological risk factor is identified to be low risk but with a reasonable expected success of intervention. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act.
There were no identified factors considering Partnership, IPR/legal and Environmental risks, therefore these aspects require no monitoring or action.

3.6 **KER NO.6** - HARMONISATION AND STANDARDISATION ACTIVITY IN HVDC PROTECTION TOPICS

KER Leading Partner: KU Leuven

3.6.1 CHARACTERIZATION OF THE RESULT

Characterization: Harmonisation and standardisation activity in HVDC protection topics	
Problem	To enable effective operation, the multivendor HVDC systems of the future will require robust harmonisation and/or standardisation, including regarding specifications, functional requirements, and test procedures to evaluate functional performance. Presently there is a lack of consensus surrounding the design of HVDC protection systems and a lack of functional requirements and functional test procedures for HVDC protection equipment.
Alternative solution	Not applicable
Unique Selling Point USP - Unique Value Proposition UVP	European competence centre in HVDC protection for multiterminal VSC-HVDC systems, with strong background in design of HVDC protection systems, functional testing of protection IEDs, and associated power system level simulation studies. Standout knowledge in system studies for HVDC protection. Within the PROMOTioN project KU Leuven have developed detailed case studies presenting trade-offs in DC-side protection, in particular focusing on fully selective protection strategies and the associated pole rebalancing equipment that would be required in a symmetrical monopolar system. Additionally, test procedures have been developed by KU Leuven in order to evaluate the accuracy and functional performance of HVDC protection IEDs. This novel work has allowed KU Leuven to contribute to harmonisation and propose a new topic for standardisation in this field.
Description	Based on the work performed by KU Leuven within the PROMOTioN project there have been several contributions to harmonisation and standardisation bodies. These contributions have been to Cigré technical working groups (Cigré A3, B4) as well as to an IEC technical committee (IEC TC95).
"Market" – *Target market* (Customers)	IEC, IEEE, CIGRÉ
Early Adopters	Industry/manufacturers developing the first HVDC protection IEDs.
"Market" - Competitors	Not applicable
Go to Market – Use model	Contribution to international standards (IEC TC95 MT4) and pre-standardisation documents (CIGRÉ B4 and A3) through a range of HVDC protection topics.
Go to Market – IPR	None
Go to Market – IPR	Work carried out by KU Leuven within Work Package 4 of the PROMOTioN project, including development of functional test procedures for HVDC protection IEDs.
Go to Market	Directly after the project.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		x
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner		x
		A group of partners		
	A new research project (application to public funded research programmes)	A partner		x
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		x
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		x
		A group of partners		
	Licensing IPR	A partner		x
		A group of partners		
	Development of a new legislation/standard	A partner	x	
		A group of partners		
	Spin- off	A partner		x
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

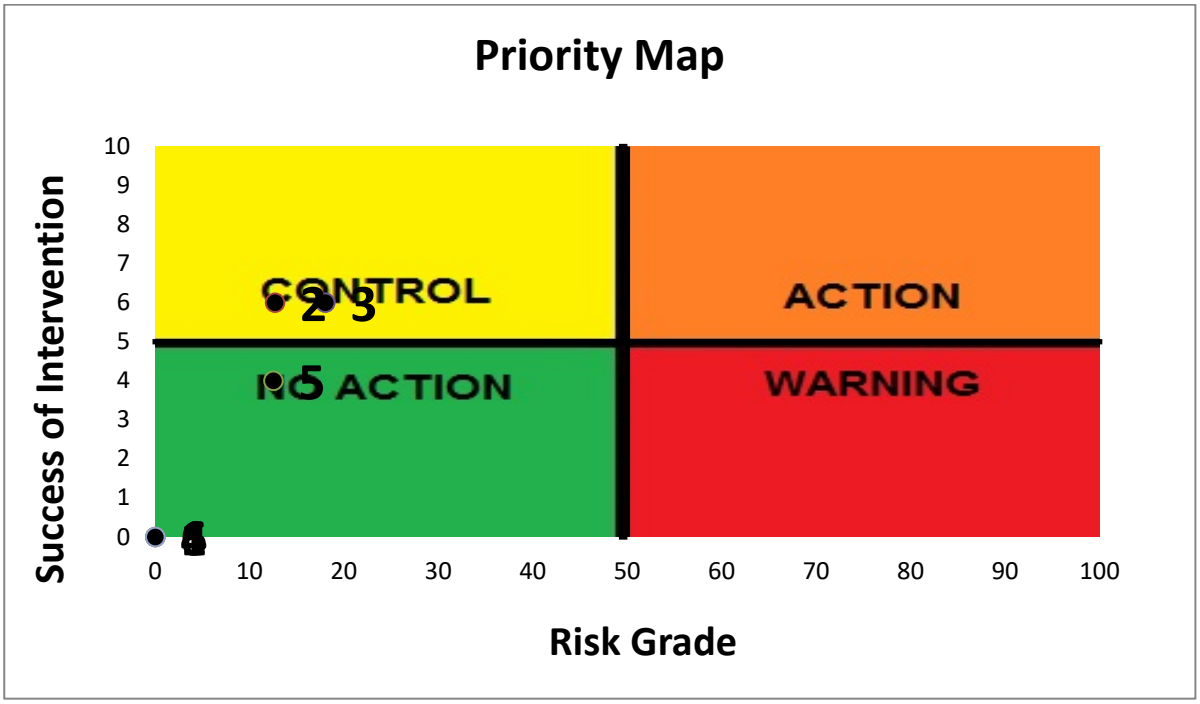
3.6.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	Continue ongoing harmonisation/standardisation activity. Seek out new working groups if/when applicable as work develops.
Roles	Contributions by KUL only
Milestones	Acceptance of scope/ terms of reference for the harmonisation activity. Approval of table of contents of document. Approval of draft document. Approval of final proposed standard or harmonisation document.
Impact in 3-years time	Draft standards under discussion by industrial contributors
Financial costs	May require membership fee to be paid. No other upfront investment costs.
Revenues	No direct revenue
other sources of coverage	Not applicable

3.6.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
2	**Technological Risk Factors**	***6***	***2***			***6***	
	better technology emerges	*7*	*2*		Ongoing research and internal information dissemination to ensure that we remain leaders in HVDC protection know how.	*6*	
	Worthless result: better technology/methodology exists.	*8*	*1*	**12,7**	Ongoing research and internal information dissemination to ensure that we remain leaders in HVDC protection know how.	*6*	**76,0**
	Result aiming at replacing existing and well entrenched technologies	*4*	*3*		Continue to make robust technical assessment of existing solutions allowing for strong arguments to be made for new technology solutions. Gain support of group of international experts (harmonisation technical committee).	*6*	
3	**Market Risk Factors**	***6***	***3***			***6***	
	difficulty in market penetration/customer reception and acceptance of technology	*6*	*3*	**18,0**	We may come across challenges persuading manufacturers that such harmonisation is required. To mitigate this, we should begin dissemination early and plan to involve key manufacturers at every stage.	*6*	**108,0**
5	**Financial/management Risk Factors**	***5***	***3***			***4***	
	weak exploitation of the material	*7*	*3*		revision of exploitation plan and market research and aim to promote services in a stronger manner.	*2*	
	No resources (human and/or financial) secured to make the next step toward exploitation	*3*	*2*	**12,5**	Increased development in research group. Presentation of PROMOTioN work to university students which may result in additional internal human resources becoming available. Use of external parties (in technical committees) in harmonisation work.	*6*	**50,0**

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The financial/management risk factor presents a low-risk grade coupled with a high probability of success of the planned remedy.
The market and technological risk factors are identified to be low risk but with a reasonable expected success of intervention. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act.
There were no identified factors considering Partnership, IPR/legal and Environmental risks, therefore these aspects require no monitoring or action.

3.7 **KER NO.7** - EDUCTATION IN THE FIELD OF HVDC PROTECTION

KER Leading Partner: KU Leuven

3.7.1 CHARACTERIZATION OF THE RESULT

Characterization: Education in the field of HVDC protection	
Problem	Lack of support for multiterminal HVDC systems resulting in suboptimal investments in industrial systems. Lack of high quality teaching materials and courses regarding state of the art HVDC protection topics.
Alternative solution	Not applicable
Unique Selling Point USP - Unique Value Proposition UVP	European competence centre in HVDC protection for multiterminal VSC-HVDC systems, with strong background in design of HVDC protection systems, functional testing of protection IEDs, and associated power system level simulation studies. Standout knowledge in system studies for HVDC protection. Within the PROMOTioN project KU Leuven have developed detailed case studies presenting trade-offs in DC-side protection, in particular focusing on fully selective protection strategies and the associated pole rebalancing equipment that would be required in a symmetrical monopolar system. High quality existing academic courses within which the latest research should be included.
Description	With the background of the extensive work presented by KU Leuven in the PROMOTioN project, we are well placed to perform education in the field of HVDC protection. Dissemination of recent HVDC protection research would be attractive in university courses taught within a range of KU Leuven undergraduate/graduate level courses.
"Market" – *Target market* (Customers)	Academic education within the existing courses provided by the Electrical Enginneering Department (ESAT) at KU Leuven.
Early Adopters	Students at KU Leuven
"Market" - Competitors	Not applicable
Go to Market – Use model	Market model already established for academic teaching activities.
Go to Market – IPR	
Go to Market – IPR	Work carried out by KU Leuven within Work Package 4 - tasks 4.2 and 4.3 - of the PROMOTioN project, in particular focusing on fully selective HVDC protection strategies, pole rebalancing, multivendor HVDC protection systems, and testing of HVDC protection IEDs.
Go to Market	Directly after the project.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		x
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner		x
		A group of partners		
	A new research project (application to public funded research programmes)	A partner		x
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner	x	
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		x
		A group of partners		
	Licensing IPR	A partner		x
		A group of partners		
	Development of a new legislation/standard	A partner		x
		A group of partners		
	Spin- off	A partner		x
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

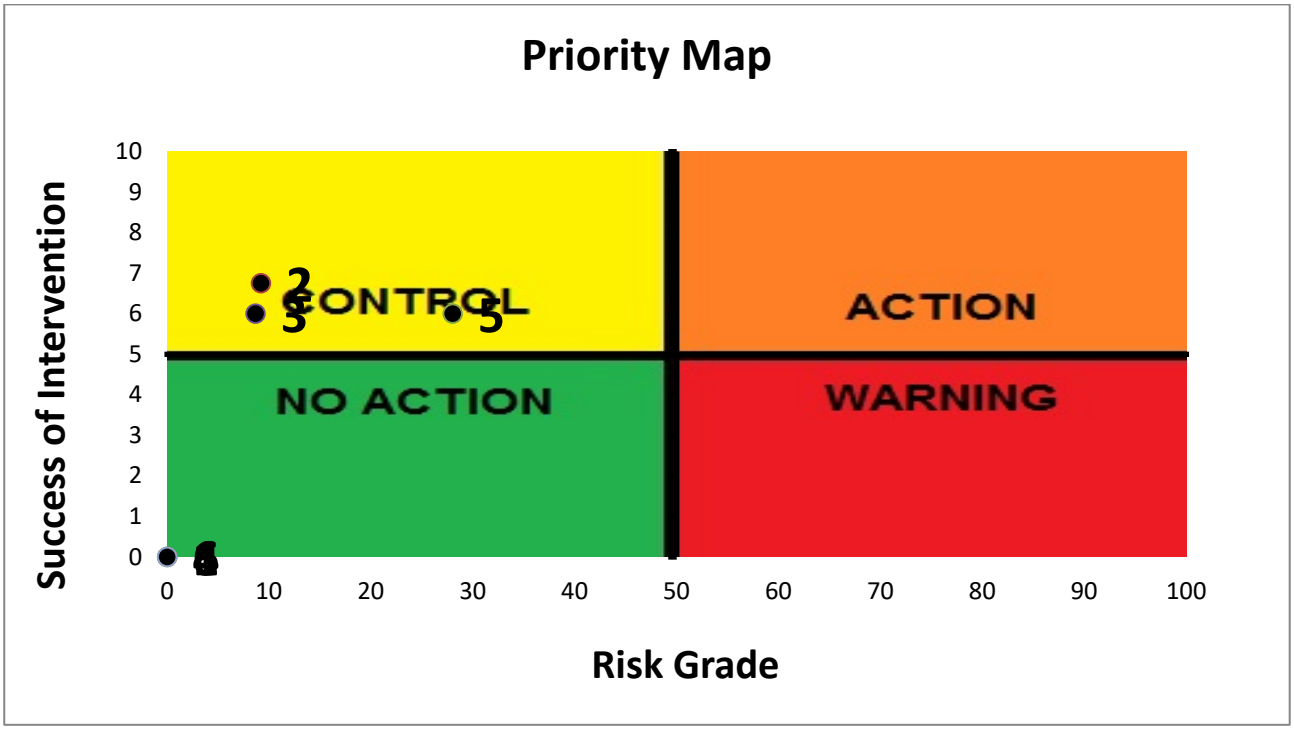
3.7.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	*Announcements to students*
Roles	*Activity only by KUL.*
Milestones	*Updating course materials. Feedback from students following first iteration of updated course.*
Impact in 3-years time	*Continuted development of PROMOTioN material into academic course content.*
Financial costs	*No upfront investment costs.*
Revenues	*Operational costs fully covered by existing academic teaching budgets.*
other sources of coverage	*Not applicable.*

3.7.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
2	**Technological Risk Factors**	***2***	***5***	**9.2**		***7***	**62.0**
	better technology emerges	*2*	*6*		Ongoing research and internal information dissemination to ensure that we remain leaders in HVDC protection know how.	*8*	
	limited market (flow limitations)	*2*	*6*		Being proactive in encouraging students to study HVDC protection.	*8*	
	Result aiming at replacing existing and well entrenched technologies	*1*	*8*		Continue to make robust technical assessment of existing solutions allowing for strong arguments to be made for new technology solutions.	*5*	
3	**Market Risk Factors**	***2***	***4***	**8.7**		***6***	**52.0**
	difficulty in market penetration/customer reception and acceptance of technology	*2*	*5*		additional examination of interest from students and future employers (industry). Assessment of shortfalls in (possible) courses that we could provide.	*7*	
	Nobody buys the product. The project hits against a monopoly.	*2*	*3*		Further development of course material to overcome deficiencies. Improved advertising to students.	*4*	
	Nobody buys the product. Rejected by end-users.	*2*	*5*		Increase confidence in our teaching of state of the art work by continuing to publish high quality and relevant research.	*7*	
5	**Financial/management Risk Factors**	***7***	***4***	**28.0**		***6***	**168.0**
	weak exploitation of the material	*6*	*3*		Revision of exploitation plan and aim to promote courses in a stronger manner.	*5*	
	No resources (human and/or financial) secured to make the next step toward exploitation	*8*	*5*		Continued development in research group and associated teaching activities. Presentation of PROMOTioN work to undergraduate/masters students which may result in additional human resources becoming available.	*7*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The market, financial/management and technological risk factors are identified to be low risk but with a reasonable expected success of intervention. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act.
There were no identified factors considering Partnership, IPR/legal and Environmental risks, therefore these aspects require no monitoring or action.

3.8 **KER NO.8** - DC GRID PROTECTION SYSTEM (PROMOTION INTELLIGENT ELECTRONIC DEVICE, IED)

KER Leading Partner: KTH Royal Institute of Technology

3.8.1 CHARACTERIZATION OF THE RESULT

DC Grid Protection System (PROMOTioN Intelligent Electronic Device, IED)	
Problem	The HVDC customers (TSO or commercial) have two major problems with regard to verification of HVDC protection systems: • Firstly, vendor interoperability of the protection system is difficult (lack of standards for instance); • Secondly, the supplied equipment is often black-boxed which as a result requires a lot of interaction between the customer and the supplier. These issues also concern academics and independent technology developers like DNV GL for instance that may want to develop and validate HVDC protection systems. An HVDC protection intelligent electronic device (IED) cannot be bought off-the-shelf and it is not possible for the customer to alter available solutions themselves according to the customers' needs.
Alternative solution	Off-line simulation is an alternative for studying and validating HVDC protection systems. However, it does not cover all studied aspects. In many cases real-time simulations are preferred since these allow for use of the actual control hardware and software. For actual HVDC equipment, so far, the customers had to stick to the manufacturers' supplied solution(s) and could not change equipment. In particular, here are no HVDC protection IEDs available in the market. Academics, Researchers and independent technology suppliers who would like to develop and verify HVDC protection systems have had to develop their own hardware, which is costly and time consuming.
Unique Selling Point USP - Unique Value Proposition UVP	The IED is the only known open-source (this means that it can be modified) device available, and therefore provides a unique combination of several benefits; low cost, openness, low effort and high flexibility for future users -a combination that we believe is attractive to users in both industry and academia. To summarize: • No other solutions are available • Low cost • Added value • Open source, freely available. • Customizable • Flexibility • Ease of configuration • 12 protection algorithms already implemented It is not an industrial-grade device, however suitable for pre-studies and research and development work without lengthy and complicated legal issues needing to be addressed.
Description	An open-source and low-cost HVDC protection IED compatible with real-time simulators. This protection IED is suitable for pre-studies and future research. It is already being used to develop test procedures which are aimed at future harmonisation/standardisation work.

"Market" – *Target market* (Customers)	TSOs and commercial HVDC customers with good knowledge and a good R&D department. Academia and research institutes using the product for further research. TSOs using HVDC exist in most parts of the world. Notable examples in Europe are TenneT (NL), 50 Hertz DE), Also, academic institutions, globally
Early Adopters	Universities, research facilities, and TSOs for example. In Europe. SHE Transmission (in UK) early adopter who already uses the IED for real-time simulation.
"Market" - Competitors	The existing manufacturers of HVDC equipment have similar, proprietary solutions. An example is the IED provided by Mitsubishi Electric to PROMOTioN. The Mitsubishi IED will be investigated and compared to the KTH-PROMOTioN one. That will show how they compare performance-wise. However, the manufacturers' products all lack the benefit of being open-source. However, an open-source device is new and the first time this has been done for software and hardware for an HVDC protection IED. We are not aware of other people developing an open-source IED with similar performance and features
Go to Market – Use model	The use model is to provide the IED as open-source material for different people to work with it. Ideally, the community will make the product grow and develop. In addition to the development of the IED itself, it will also be used in related research - e.g. demonstration of protection systems in real-time, harmonisation/standardisation activity regarding HVDC IEDs specifications/ratings, harmonisation/standardisation activity regarding functional testing of HVDC IEDs.
Go to Market – Background IPR	Existing knowledge and code for Zynq SoC platform (all KTH, P4 in PROMOTioN project). First Freedom to Operate study made indicates no interfering IPR.
Go to Market – Foreground IPR	Development of IP for IED software/firmware, development of IP for IED hardware (interfaces and casing), development of IP for software interface.
Go to Market	Gradual roll-out with early customers like SHE transmission and RWTH. IED can be manufactured by contract manufacturers according to existing OS specs. .

3.8.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	Establish open-source community. Publications, conferences, Start CIGRE workgroup
Roles *Roles of partners involved*	KUL support further development, SHE Transmission (early adopter) gives user feedback
Milestones	Set up GITHUB, Establish CIGRE workgroup, Complete documentation online (before end of PROMOTioN)
Impact in 3-year-time	10+ academia / commercial users
Financials **Costs**	Personnel for maintenance 10% FTE, conference participation, travel
Revenues	Follow-up projects on OS software for HVDC etc
Other sources of coverage	

3.8.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***5***	***5***	**25,0**		***6,5***	**162,5**
	Disagreement on ownership rules	*8*	*2*		Open discussion within the project. Obtain all partners positions.	*8*	
	Disagreement on further investments: some partners may leave.	*2*	*8*		Refers to post project conditions. Good documentation, Competence transfer when people leaves.	*5*	
2	**Technological Risk Factors**	***5***	***3***	**15,0**		***6.5***	**97,5**
	Worthless result: ill-timed disclosure.	*5*	*1*		Faster publication.	*8*	
	Worthless result: earlier patent exists.	*5*	*1*		Do FTO study	*5*	
	The life cycle of the new technology is too short.	*5*	*4*		Avoid/check the use of external IP cores.	*5*	
	Significant dependency on other technologies.	*5*	*6*		Create interfaces for other RT simulators	*8*	
3	**Market Risk Factors**	***8***	***2***	**16,0**		***8***	**128,0**
	Exploitation disagreement	*8*	*2*		Discuss exploitation proposals and ensure that open-source exploitation is beneficial and in the interest of marketing the technology	*8*	
	Nobody buys the product. Rejected by end-users.	*8*	*2*		Be active with publications, Cigré workgroups. Collaborations	*8*	
4	**IPR/legal Risk Factors**	***8***	***1***	**8,0**		***5***	**40,0**
	Legal problems: we are sued for patent infringement.	*8*	*1*		Perform FTO study. Act in accordance with results	*5*	
5	**Financial/management Risk Factors**	***8***	***8***	**64,0**		***8***	**512,0**
	No resources (human and/or financial) secured to make the next step toward exploitation	*8*	*8*		Follow-up projects planned that will take over technology and market	*8*	
6	**Environmental/regulatory Risk Factors**	***8***	***2***	**16.0**		***9***	**144**
	Product/service does not comply with the standards.	*8*	*2*		Assessment of legal/regulatory requirements and alteration of product to comply	*9*	

Priority map of Exploitable result

Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Financial/Managements risk factors present a high-risk grade with a high probability of success for the remedy action defines a situation where there is the need for an immediate action to ensure exploitation (action), as for example to follow-up projects planned that will take over technology and market.

The Partnership, Technological, Market risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act. Considering Partnership risk factors a potential intervention should be an open discussion within the project.
For Technological risks a potential intervention could be a faster publication or creating interfaces to other RT simulators. For the Market risks a solution should be discussing on exploitation proposals and be active with publications.

The IPR/legal risks present a situation between Control and No action, where is a low risk grade with a medium probability of success of the planned remedy.

3.9 **KER NO.9** - INCREASED KNOWLEDGE ABOUT OFFSHORE WIND AND MESHED OFFSHORE GRID

KER Leading Partner: EirGrid

3.9.1 CHARACTERIZATION OF THE RESULT

Increased Knowledge about Offshore Wind and Meshed Offshore Grid (MOG)	
Problem	EirGrid has limited amount of inhouse knowledge of HVDC offshore grids and technologies. Increased knowledge lets EirGrid consider these solutions in future work and are more prepared if they get market inquiries about it
Alternative solution	1. Hire individuals with relevant knowledge or retain power systems consultants with knowledge of HVDC grids and technologies, 2. Ignore it
Unique Selling Point USP - Unique Value Proposition UVP	Through having inhouse knowledge, EirGrid can develop their own functional specifications and associated documentation for HVDC projects in the future. EirGrid can also build som prior knowledge if market stakeholders make inquiries. In the right situation, DC grid concepts can offer lower investment costs and higher flexibility.
Description	Gain of HVDC knowledge and awareness with respect to TRL of key technologies, meshed offshore grid development strategies and HVDC protection equipment and protection strategies. EirGrid also has a better overview of the European resource base on HVDC technology, both within industrial and R&D sectors.
"Market" – *Target market* (Customers)	The customers are teams within EirGrid and having the availability of in-house HVDC knowledge. Instead of procuring consultants or outside experts. Ultimately the target customers are Irish grid users who pay grid tariffs. With EirGrids new knowledge they are in a better situation to identify and analyse the need and use for offshore wind and MOG in Ireland.
Early Adopters	Interconnector, Network Planning and Innovation Teams in EirGrid
"Market" - Competitors	Key competitors are external experts in the HVDC space.
Go to Market – Use model	The inhouse competence on MOG and DC technology will be more readily available compared to consultants, and it will be easier and cheaper to benefit from their knowledge. EirGrid will report on PROMOtioN activity and make sure the right people have access to the correct competence and information should something relevant come up.
Go to Market – Background IPR	EirGrid knew very little on Meshed Offshore Grid on beforehand and, if they have shared something it has not been confidential.
Go to Market – Foreground IPR	Not relevant. EirGrid has solely participated in public open events where no confidential intellectual propoerty has been shared.

Go to Market	In the Republic of Ireland there is a government target for 70% of electricity to come from renewables by 2030. The likelihood of meshed offshore grids could be in this timeframe or later. EirGrid's new inhouse knowledge can thus be put to use in relation to planning, but for specific project use, the likely go-to-market is further ahead in time.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		X
		A group of partners		X
	Contract research (new contracts signed by the research group with external clients)	A partner		X
		A group of partners		X
	A new research project (application to public funded research programmes)	A partner		X
		A group of partners		X
	Implementation of a new university - course (Note that a training course is a service)	A partner		X
		A group of partners		X
		A new partnership		X
	Other: Knowledge enhancement and build-up	A group of partners	X	
INDIRECT USE	Transfer of ownership (IPR)	A partner		X
		A group of partners		X
	Licensing IPR	A partner		X
		A group of partners		X
	Development of a new legislation/standard	A partner		X
		A group of partners		X
	Spin- off	A partner		X
		A group of partners		X
		By assignment		X
		By licensing		X
	Application of knowledge in a alternative HVDC space	A partner		X
		A group of partners		X

3.9.2 EXPLOITATION ROADMAP

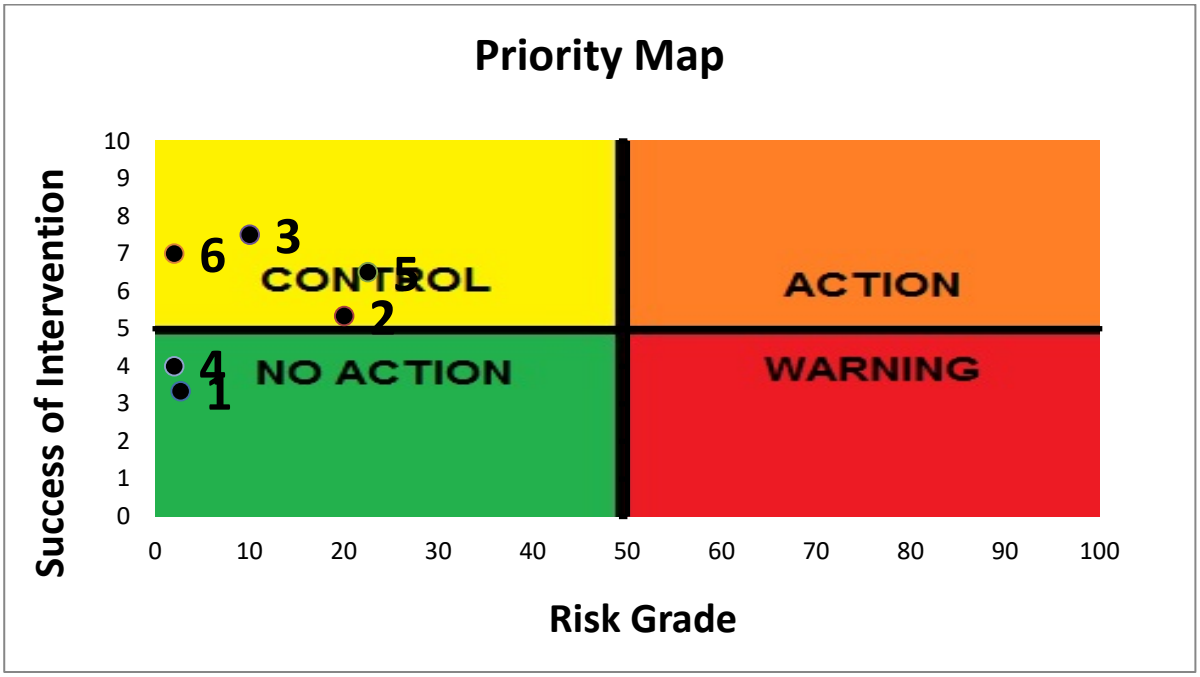
Exploitation roadmap	
Actions	During the project and if necessary, after the project, the EirGrid employees who have participated in PROMOTioN, will pass on relevant information from deliverables, make sure relevant competence in EirGrid can profit from findings in PROMOTioN, give presentations about the project and its purpose
Roles	Some cooperation with other TSOs might be relevant, especially with British TSOs, but also through CIGRE, ENTSO-e and other European and international fora of cooperation on grid development and regulation.
Milestones	Presentation and dissemination of relevant project results within EirGrid. This information sharing will be used to understand TRL of key technologies that is relevant when/if developing - Meshed offshore grid development strategies - HVDC protection equipment and protection strategies
Impact in 3-years time	Offshore wind farms are a key part of the plan to make sure Ireland has 70 percent renewable electricity consumption in 2030. Meshed offshore grid knowledge and awareness enable potential wider scope when planning beyond 2030.
Financial costs	All costs will be covered internally. The amount of man-hours used will not be that large, and no new positions or similar will be created because of it.
Revenues	All costs will be covered by EirGrid's internal budget for R&D and knowledge developmet. This money is levied through Irish grid tariffs.
other sources of coverage	N/A

3.9.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***3***	***1***	**2,7**		***3***	**8,9**
	Disagreement on ownership rules	*1*	*1*		Legal mediation of downership disputes and patent review	*1*	
	Industrialization at risk: a partner declares bankruptcy.	*5*	*1*		initiate consortium meeting toexplain usage issues and redefine roadmap of exploitation	*4*	
	Industrialization at risk: an business partner leaves the market.	*2*	*1*		maintain communication with exiting expert and organise hand-over and training	*5*	
2	**Technological Risk Factors**	***7***	***3***	**20,0**		***5***	**106,7**
	better technology emerges	*7*	*4*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*6*	
	limited market (flow limitations)	*7*	*3*		redesign of valve configuration to enhance range of device	*3*	
	Result aiming at replacing existing and well entrenched technologies	*6*	*2*		correctly assess existing market technologies and assess performance and ability to penetrate market through replacement in exisiting applications	*7*	

3	**Market Risk Factors**	***4***	***3***	**10,0**		***8***	**75,0**
	Exploitation disagreement	*2*	*2*		discuss exploitation proposals and ensure that parallel exploitation is beneficial and in the interest of marketing the trechnology	*8*	
	difficulty in market penetration/customer reception and acceptance of technology	*6*	*3*		additional market studies, customer surveys and assessment of product shortfalls	*7*	
4	**IPR/legal Risk Factors**	***1***	***2***	**2,0**		***4***	**8,0**
	competitors replicate technology	*1*	*2*		stricter control in in patent usage and aggressive pursuit of legal action	*4*	
5	**Financial/management Risk Factors**	***5***	***5***	**22,5**		***7***	**146,3**
	No resources (human and/or financial) secured to make the next step toward exploitation	*4*	*6*		Engage with resources internal and extrenal to maintain and keep in house knowledge	*7*	
	Inadequate communication among partners.	*6*	*3*		Continue engagement and communication post PROMOTioN	*6*	
6	**Environmental/regulatory Risk Factors**	***2***	***1***	**2,0**		***7***	**14,0**
	not in compliance with regulations	*2*	*1*		assessment of legal/regulatory requirements and alteration of product to comply	*7*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Partnership and Technological risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act. The Partnership risks should maintain a communication with exiting expert and organised a hand over and training. Considering the Technological risk factors the technology should be re-evaluated and further optimised to match/outperform new benchmark.

Considering Market, IPR/legal, Financial/Management and Environmental risk factors have been registered a low-risk grade and a low probability of success for the remedy, this situation does not call for immediate action.

3.10 **KER NO.10 -** PARTIAL DISCHARGE MONITORING SYSTEM IN HIGH VOLTAGE DIRECT CURRENT GAS INSULATED SWITCHGEAR

KER Leading Partner: Supergrid Institute (SGI)

3.10.1 CHARACTERIZATION OF THE RESULT

Partial Discharge Monitoring System in High Voltage Direct Current Gas Insulated Switchgear	
Problem	1) Technical problem: lack of PD (Partial Discharge) monitoring system in HVDC (High Voltage Direct Current) GIS (Gas Insulated Switchgear) which helps detect defects in order to take preventing actions and increase equipment reliability as well as to give confidence in HVDC GIS technologies; 2) Ecological problem: EU goal by 2030 is to reduce greenhouse gas emissions by 40% , the current used SF6 contributes strongly to the greenhouse gas emissions, replacing SF6 in all GIS (AC - Alternating Current and DC- Direct Current) is a must.
Alternative solution	1) No PD monitoring for HVDC GIS - use of AC monitoring system; 2) Use of SF6 (Sulfur hexafluoride) in HVDC GIS;
Unique Selling Point USP - Unique Value Proposition UVP	UVP: 1) A methodology of how to measure PD in HVDC GIS and detect critical defects; 2) Possibility to use the methodology with different gases (not just SF6).
Description	1) A PD monitoring system for HVDC GIS; 2) Fits SF6 and on its substitute gases. The monitoring system requires measurement equipment which consist of the system hardware that fits in the box and a software operated by a normal computer to automatically analyse and detect defects. - PD monitoring system Impact on GIS manufacturer as well as on TSOs (Transmission System Operators): It contributes in giving TSOs confidence in HVDC GIS technologies which enable DC GIS manufacturers market uptake. Thanks to this system a TSO operator can take the most appropriate, less expensive countermeasures to provide power with high quality of service.
"Market" – *Target market* (Customers)	• Integrators or HVDC equipment Manufacturers in EU: SGI can sell the PD monitoring system (hardware and software) or software only for the SF6 substitute gas of the manufacturer choice. • DC grids of TSO (Transmission System Operators) in EU: SGI can be consulted for on-site diagnosis or can sell the complete monitoring system as well. • Later on, SGI can expand its market worldwide. • Cable manufacturers: same methodology can be applicable on cable junction
Early Adopters	Transmission System Operators (TSO) in Europe.
"Market" - Competitors	**For complete monitoring system**: • HV equipment manufacturers: can provide HV (high voltage) equipment with their own diagnostic system. They generally don't propose to install monitoring system on competitor equipment • Third party companies developing diagnostic systems for HVAC and SF6 **For consultancies**: • HV equipment manufacturers but on their own product. • Independent companies, lack the competencies on SF6 substitute gases.
Go to Market – Use model	• Proposing a license with royalties: % of benefits. • Or: sell the complete monitoring system for TSOs • On site expertise

Go to Market – Background IPR	- Fundamental knowledge on GIS design and testing (AC & DC); - Basic knowledge on material insulation; - Knowledge in Partial discharges AC GIS filled with SF6; - Monitoring system: conventional and non-conventional.
Go to Market – Foreground IPR	- Knowledge on PD characteristics in DC GIS filled with SF6 and some alternative gases; - Long term behaviour of a DC GIS with defect and different sensors.
Go to Market	It depends on DC GIS market.

3.10.2 EXPLOITATION ROADMAP

Exploitation roadmap	
Actions	End of PROMOTioN project: Q2 2020 • Create communication materials • First prototype of PD monitoring system • Find pilot project with TSO and industrial partners to test in real conditions
Roles	No roles for other partners after the project has ended
Milestones	Create communication materials: Q4 2020 First prototype of PD monitoring system: Q4 2020 Find pilot project with TSO and industrial partners to test in real conditions: Q2 2021 1 year of real conditions application: Q2 2022
Impact in 3-year-time	Know-how in DC GIS monitoring Development of SGI (P12 of PROMOTioN project) expertise services for TSOs: benefits + job creation
Financials Costs	All activities listed in "milestones": 500 k€
Revenues	From SGI budget To properly answer the revenues question, SGI is in need of a market study on DC GIS
Other sources of coverage	_

3.10.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***5,5***	***2***	**11,0**		***8,5***	**93,5**
	Disagreement on ownership rules	*1*	*1*		Legal mediation of ownership disputes and patent review	*10*	
	Industrialization at risk: no TSO/manufacturer for the exploitable result	*10*	*3*		Active involvement of components suppliers	*7*	
2	**Technological Risk Factors**	***7,3***	***4***	**29,3**		***8***	**234,7**
	Worthless result: difficulties to detect defects	*9*	*5*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*8*	
	Difficulties to define reliable threshold to support maintenance decision	*5*	*5*		Redesign of system configuration to enhance range of device	*8*	
	Worthless result: better technology/methodology exists	*8*	*2*		Correctly assess existing market technologies and assess performance and ability	*8*	
3	**Market Risk Factors**	***8,6***	***3,4***	**29,2**		***6,4***	**187,1**
	DC GIS market has some difficulties to ramp-up	*10*	*3*		Increase TRL of DC GIS	*8*	
	Nobody buys the product. Nobody needs it.	*10*	*1*		Find early TSO adopter	*5*	
	Worthless result: performance lower than market needs.	*10*	*5*		Show that technological locks are solved	*7*	
	The lack of standard	*5*	*5*		Be aware of standardization works	*10*	
	Competitor product on the market at the same time	*8*	*3*		Follow competitor publications	*2*	
4	**IPR/legal Risk Factors**	***8***	***1***	**8,0**		***5***	**40,0**
	competitors replicate technology	*8*	*1*		Patent usage	*5*	

5	**Financial/management Risk Factors**	***8,3***	***5,7***	**47,2**		***7,3***	**346,3**
	Know- how risks: there are leaks of confidential information	*10*	*3*		NDA	*7*	
	Weak exploitation: Inadequate business plan	*7*	*7*		Work closely with DC GIS community	*8*	
	No resources (human and/or financial) secured to make the next step toward exploitation	*8*	*7*		Put more resources on marketing and exploitation	*7*	
6	**Environmental/regulatory Risk Factors**	***5***	***2***	**11,7**		***10***	**110,8**
	Research is socially or ethically unacceptable	*1*	*1*		Assessment of legal/regulatory requirements and alteration of product to comply	*10*	
	Influence of laws and regulations	*8*	*5*		Constantly monitor relevant laws and regulations	*10*	
	Product/service does not comply with the standards	*6*	*1*		Follow standardization actions	*9*	

Priority map of Exploitable result

Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Partnership, Technological, Market, Environmental, Financial risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act.
Considering Partnership risk factors a potential intervention should be a legal mediation of ownership disputes and patent review. For Technological risks a potential intervention could be a re-evaluation of technology and further optimisation to match/outperform new benchmark. The Market risks present that DC GIS market has difficulties to ramp-up, a potential intervention should be to increase TRL of DC GIS, and in case there is a lack of standards, be aware that this process will work.

In case of Financial risk factors some solutions should be to work closely with DC GIS community to improve the work on business plan and use NDA in case of risks of leaks of confidential information.
For environmental/regulatory risk factors a potential solution should be an assessment of legal/regulatory requirements and alteration of product to comply.

The IPR/legal risks present a situation between Control and No action, where is a low risk grade with a medium probability of success of the planned remedy.

3.11 **KER NO.11** - DESIGN AND KPI ASSESSMENT OF HVDC GRID PROTECTION STRATEGIES AND LAYOUT

KER Leading Partner: Supergrid Institute (SGI)

3.11.1 CHARACTERIZATION OF THE RESULT

Design and KPI assessment of HVDC grid protection strategies and layout	
Problem	Multi-terminal direct current (MTDC) grid is still at an early phase of deployment. It is important to know what are the technological options to protect the grid (components, layout, scheme) in addition to considering the readiness of the technology available. It is difficult to select the best protection system and layout for a given MTDC grid, regarding cost, operating constrains and extensibility issues.
Alternative solution	Issue a call for tender: HVDC manufacturers propose their own protection systems (turnkey system, no interoperability). It is is also an option to not pursue the deployment of MTDC, but this is not considered in this KER.
Unique Selling Point USP - Unique Value Proposition UVP	Our approach is structured and supported by a software tool, that capitalizes on extensive screening and analysis studies and elaborate cost and performance models or indicators as input. This software tool has the following benefits: - Ability to quickly derive preliminary specifications. - Neutral analysis, vendor agnostic approach. - Upfront derisking and optimization of expensive MTDC projects leading strong benefits for the customer at a relatively low price point. - Independant framework that can bring credibility to marketing campaigns of HVDC solution providers.
Description	The software assists early on in the MTDC project phase to : - Identify and propose protection systems options (technological components and the layout) - Give preliminary specifications of the components of the protection system (simplified model, to be confirmed with additionnal extensive EMT simulations) - KPIs can be computed (economics: CAPEX / OPEX; technical: efficiency indicators / risk indicators / Impact on AC grid) - Compare and select the best protection systems according to KPIs, respecting specific project constraints (operational...)
"Market" – Target market (Customers)	B2B Consulting / engineering: - Assistance in early MTDC project phase such as predesign studies, tendering, Front End Engineering and Design studies. - Generic assessment of a given protection system Customer segments: TSOs / system integrators / MTDC project developers
Early Adopters	MTDC project developers TSOs surrounding the North and Baltic seas
"Market" - Competitors	Engineering / Consulting firms and independants

	- Strengths: integrated support for projects, including all aspects from legal, contractual up to technical, big amount of data for model validation, strong references - Weaknesses: lack of structured and systematic approach to compare and optimize on MTDC protection systems (partial and/or empricial analysis). Internal engineering teams from TSOs or manufacturers - Strengths: field experience, access to data - Weaknesses: potential lack of expertise on MTDC protection systems
Go to Market – Use model	Provision of a service Possibly licensing (but less added value than comprehensive consulting study)
Go to Market – Background IPR	Prevously existing expertise: modelling, control and protection for HVDC grids. Cost models.
Go to Market – Foreground IPR	Risk analysis for HVDC grid protection KPI definition and protection assesment methodology. New cost models.
Go to Market	2021

KER's Exploitation Form
(how the KER will be further exploited – Select only an option)

Selected route		Implementing actor	Yes	No
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	x	
		A group of partners	maybe	
	Contract research (new contracts signed by the research group with external clients)	A partner	x	
		A group of partners	maybe	
	A new research project (application to public funded research programmes)	A partner	x	
		A group of partners	maybe	
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		
	Other: Knowledge/competence build-up			x

3.11.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	Dissemination of product performance possibilities. Development of an inhouse consolidated version of protection strategy assessment tool as a user friendly tool (the tool will be used and adjusted during Grid Consulting activities, e.g. Bornholm study). Prospect for consulting activities: share scope of our offer (our perimeter) and have feedback from prospects. Need to be referenced as a supplier among TSO and HVDC vendors. Be part of an EU project. Monitor EU call on coordinated planning of MTDC grids.
Roles	SuperGrid institute will perform protection strategy and layout assesment.
Milestones	2021 start of consulting activities. 2022 extension of inhouse software tool from protection assessment to overall HVDC grid architecture optimization.
Impact in 3-years' time	Support HVDC development and emergence of MTDC grids in Europe to allow large integration of renewables and power electronics-interfaced devices. At least one job already created, more to come depending on commercial activities.
Financial costs	Cost of alpha version software development
Revenues	Contract with costumers
other sources of coverage	EU funded potential research projects (for the extended perimeter of the tool)

3.11.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***1***	***1***			***8***	
	Disagreement on ownership rules	*1*	*1*	**1,0**	Specified in Grant Agreement, Article 31.3 Access rights for other beneficiaries, for exploiting their own results. Ask for mediation.	*8*	**8,0**
2	**Technological Risk Factors**	***8***	***2***			***8***	
	Worthless result: better technology/methodology exists.	*8*	*2*	**16,0**	Re-evaluation of methodology and further optimisation to match/outperform new benchmark	*8*	**128,0**
3	**Market Risk Factors**	***7***	***8***			***7***	
	Difficulty in market penetration/customer reception and acceptance of methodology	*7*	*8*	**56,0**	Dissemination of product performance possibilities	*7*	**392,0**
5	**Financial/management Risk Factors**	***4***	***3***			***6***	
	No resources (human and/or financial) secured to make the next step toward exploitation	*1*	*1*	**8,8**	Look for new resources	*5*	**52,5**
	Know- how risks: there are leaks of confidential information.	*6*	*4*		Non disclosure agreement	*7*	
6	**Environmental/regulatory Risk Factors**	***5***	***2***	**10,0**		***8***	**80,0**
	Influence of laws and regulations.	*5*	*2*		assessment of legal/regulatory requirements and adaptation of product to comply	*8*	

Priority map of Exploitable result

Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

In order to well establish the possible added value of the HVDC grids (compared to AC), an in depth risk/benefit analysis must be carried out taking into account investment and operating costs and easiness toward extensibility. The proposed KPI based methodology takes into account such elements, neverthless this approach has some underlying assumptions that need to be monitored:

- Market risk : TSO and power system developers need to be aware about the risk/benefits of HVDC grids compared to AC grids; the dissemination and the acceptance of the proposed tool is therefore of preliminary importance.
- Technical risk: The techno economic analysis need to have realistic input data regarding cost but also regarding AC system parameters. A collaboration with TSO would be beneficial for the strengthening of the proposed methodology. Level of readiness of the proposed technology need to be taken into account.
- Environmental /regulatory risk: Technical and economic choices need to be cross-checked with constraints coming from laws and regulations.

3.12 **KER NO.12** - DEVELOPMENT AND HARDWARE IN THE LOOP VALIDATION OF HVDC GRID CONTROL & PROTECTION SYSTEM

KER Leading Partner: SuperGrid Institute (SGI)

3.12.1 CHARACTERIZATION OF THE RESULT

Development and Hardware In the Loop (HIL) Validation of HVDC Grid Control & Protection System	
Problem	The main technical locks to Multi Terminal HVDC grids (MTDC) development are: • Control and coordination of the MTDC including stability and management; • Protection of the MTDC; • Stability of the connected AC areas, AC ancillary services through the MTDC; • Interoperability within multivendor MTDC schemes (converter, protection and high voltage components)
Alternative solution	4 alternatives can be considered: • Offline simulation: less expensive, easier to use but less accurate control (no industrial control model or with high effort), no communication, limited time range (short duration and/or very slow simulation); • HIL real time simulation using in-house facilities or with other established real-time simulation organisation: strong alternative but not everyone is equipped. Requires a large investment, maintenance and expertise; • Power hardware in the loop (PHIL) real time simulation: demonstrative effect but very dependent on down-scaling and significant effort to build a mockup and the associated test bench. SuperGrid Institute was one of the first to implement such an experiment with an MMC mock-up with OPAL-RT in 2016 followed by Aachen with a larger setup (8 MMC); • Real-plant tests: expensive, risky, often too late in the project development.
Unique Selling Point USP - Unique Value Proposition UVP	SuperGrid Institute has extensive expertise in HVDC/MVDC at both system level and component level: • MTDC architecture and grid studies, DC Grid control development, control, stability, system identification, protection strategies; • Innovative power converters design and validation; high voltage components, cables and storage modelling and integration; • Complementary expertise in AC system stability analysis and wide area controls. In addition to a unique HIL competences: • master standard IEC61850 / C37.118 communication protocols implementation in combination with HVDC systems; • one of the largest MTDC systems modelled and simulated in real-time at 50 µs; SuperGrid Institute can support its customers from the design to the validation of control & protection systems (complete design flow: design, development, implementation with/without Rapid Control Prototyping and validation)
Description	Supergrid Institute can support design, specification and de-risking of MTDC projects at early stage by: • Using the real-time simulation laboratory to integrate and test interoperability of Control and Protection systems in multi-vendor configurations, • Developing the DC Grid Control layer.

	More precisely, this value proposition is supported by a complete design flow that addresses the following points:
	• Complete DC grid control development , implementation and validation:
	  o Control and coordination of the MTDC,
	  o Communication inside and outside the MTDC: inter station, protection and control, WAMPAC with IEC61850, C37.118 typically,
	  o Stability and interoperability functions;
	• DC grid protection strategies development , implementation and validation:
	  o Selective, non-selective and hybrid implementations,
	  o Interoperability and coordination validation;
	• Interoperability testing: “Multivendor-like” MTDC grid model with various MMC controls and different options of same high voltage components;
	• AC stability with embedded HVDC links and high penetration of Power Electronics Interfaced Devices;
	• The most realistic network modelling.
	
	SuperGrid Institute platform includes:
	• Real-time simulation:
	  o Hardware:
	  ▪ 2x OPAL-RT OP5700 (16 cores @ 3.2GHz, FPGA Virtex7)
	  ▪ 2x OPAL-RT OP4510 (4 cores @ 2.3GHz, FPGA Kintex 7)
	  ▪ I/Os : 32 Analog, 64 Digital, 16 SFP interfaces (fiber optic, Aurora), 12 Ethernet ports
	  o Software :
	  ▪ HYPERSIM (20 cores: up to 5000 buses at 20µs time step),
	  ▪ 4 MMC converters FPGA models (up to 512 levels at 500ns time step),
	  ▪ Matlab-Simulink suite, Simscape Electrical, RT-LAB (CPU), RT-XSG (FPGA), eHS.
	• Rapid control prototyping:
	  o Automatic code and FPGA generation,
	  o Matlab-Simulink model-based design (SuperGrid Institute or customer’s),
	  o Rapid Control Prototyping with Speedgoat: Simulink Real-Time + HDL Coder (CPU/FPGA),
	  o Rapid Control Prototyping with Opal-RT: RT-LAB + RT-XSG (CPU/FPGA);
	• Hardware-in-the-loop: closed-loop testing of control and protection systems
	  o Prototyped IED or customers’ industrial controllers,
	  o Libraries/protocol IEC 61850, C37.118;
	• Power hardware-in-the-loop: closed loop testing of real devices (scaled converter, MMC, breaker, etc.)
	  o MMC mockup
	  ▪ Rated Power: 6 kW,
	  ▪ Rated DC voltage: 400 V (pole to pole),
	  ▪ Rated AC voltage: 208 V (rms line to line),
	  ▪ Number of SMs per am: 10, SM capacitance: 4,92 mF,
	  ▪ Arm inductance/resistance: 6 mH / 35 mOhm,
	  ▪ AC filter inductance/ resistance: 5 mH / 26 mOhm;
	  o 2x Power amplifiers
	  ▪ Nominal Power 21 kVA 4Q,
	  ▪ Voltage dynamics ~ 20 µs, bandwidth 100 ~ 150 kHz,
	  ▪ Current dynamics 30-50 µs, bandwidth 15 kHz.

"Market" – *Target market* (Customers)	System developers, protection and control system vendors, converter manufacturers, HV/MV devices manufacturers, TSO, DSO, academics and labs
Early Adopters	GE Digital, Alstom, Red Electrica de Espana

"Market" - Competitors	The main competitors are other industrial or academic laboratories equipped with real-time simulation facilities: • HVDC square • National HVDC center • RWTH Aachen University • … Potential customers, like HVDC vendors, may already have real-time simulation facilities.
Go to Market – Use model	• SuperGrid Institute services and studies for customers • R&D collaborative projects • Potential contribution to standards development
Go to Market – Background IPR**	Previously existing expertise: • in HVDC control, protection and DC grid control (supervisor, master control and monitoring), • in HIL/PHIL real-time simulation including: setup of HIL test bench, real-time model implementation, IED prototyping, IEC61850 communication.
Go to Market – Foreground IPR**	Implementation and strengthening of expertise working on the PROMOTioN MTDC benchmark: non-selective protection strategies, DCCB model, DC Grid control and protection IED prototyping.
Go to Market	Already available for customer services and additional collaborative R&D project.

*DC Grid control: The DC grid control, coordinated system control in the CENELEC standard PD CLCTS 50654-1-2018, master control in Best Path, is the control layer responsible for keeping the HVDC system within the security margins during real-time operation.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	X	
		A group of partners	Maybe	
	Contract research (new contracts signed by the research group with external clients)	A partner	X	
		A group of partners	Maybe	
	A new research project (application to public funded research programmes)	A partner	X	
		A group of partners	Maybe	
	Implementation of a new university - course (Note that a training course is a service)	A partner		X
		A group of partners		X
		A new partnership		X
INDIRECT USE	Transfer of ownership (IPR)	A partner		X
		A group of partners		X
	Licensing IPR	A partner		X
		A group of partners		X
	Development of a new legislation/standard	A partner		X
		A group of partners		X
	Spin- off	A partner		X
		A group of partners		X
		By assignment		X
		By licensing		X
	Other (please describe)			X

3.12.2 EXPLOITATION ROADMAP

Exploitation roadmap	
Actions	Complete and go beyond PROMOTiON project: • Protection strategies robustness validation (component failure, backup) • Complete DC Grid control implementation and validation: include all system control and protection functions and test robustness (algorithm and controllers) • Interoperability aspects of converter control according to protection strategies Develop a DC grid control for interoperability (framework and demonstration) Wide area AC/DC system stability: HVDC link power management control for AC areas stability improvement validation in HIL real-time simulation using industrial WAMPAC components (phasor controller and PMUs) Industrialisation of the HIL platform towards customer needs Communication and prospection: R&D demonstrations, visits, conferences, digital communications Monitor EU calls for collaborative R&D projects
Roles	• SuperGrid Institute providing services expert in specification, development, implementation and HIL validation of HVDC grid Control & Protection systems; • Opened to partnership for various topics such as DC Grid control specification, industrial controllers/IED implementation and validation, concurrent MMC control for interoperability issues studies.
Milestones	• 2020: HVDC based wide area AC stability control HIL validation • 2020-2021: DC protection and DC Grid control upgrade and validation managing component failures (not only breaker but also HVDC station) • >2020: contract with customers
Impact in 3-year-time	Support HVDC development and emergence of MTDC grids in Europe to allow large integration of renewables and power electronics-interfaced devices. At least one job already created, more to come depending on commercial activities.
Financials **Costs**	Most important investment is already done. Future investment and maintenance.
Revenues	The service is ready. Future revenues: contract with customers (TSO, manufacturers, system integrators, labs).
Other sources of coverage	-

3.12.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
2	**Technological Risk Factors**	***8***	***4***	**28.0**		***8***	**224.0**
	Worthless result: better technology/methodology exists.	*8*	*4*		Refine methodology for specification, implementation and validation Update real-time simulation platform technology	*8*	
	Significant dependency on other technologies.	*8*	*3*		Platform technology: stay up-to-date, change hardware and software supplier, close interaction / anticipation with hardware and software developers	*8*	
3	**Market Risk Factors**	***9***	***5***	**35.3**		***7***	**232.8**
	Worthless result: performance lower than market needs.	*8*	*5*		Technical discussion and/or marketing investigations to understand the lack of performance. New corrective platform investments and/or developments.	*7*	
	Nobody buys the product. Nobody needs it.	*10*	*4*		Marketing and commercial actions (adapt value proposition, prospect new customers)	*5*	
	Nobody buys the product. Too expensive.	*10*	*3*		Improve operational efficiency.	*7*	
	Nobody buys the product. The project hits against a monopoly.	*7*	*6*		To specialize on a specific market target. Partner with dominating entities.	*5*	

	Nobody buys the product. Problems at the time of the first sales.	*7*	*3*		Identify and manage technical and process locks (REX)	*9*	
4	**IPR/legal Risk Factors**	***8***	***1***	**8.0**		***7***	**56.0**
	Legal problems: proceeding against us.	*8*	*1*		Customer or partner IP management at the beginning of the project, contract redaction	*7*	
5	**Financial/management Risk Factors**	***7***	***4***	**28**		***5***	**140**
	Weak exploitation: Inadequate business plan	*7*	*4*		Increase turnover through marketing & commercial actions Adapt manpower to the actual workload	*5*	
6	**Environmental/regulatory Risk Factors**	***7***	***2***	**14.0**		***5***	**70.0**
	Product/service does not comply with the standards.	*7*	*2*		Upgrade the platform to the appropriate standards	*5*	

Priority map of Exploitable result

Legend:

7. Partnership Risks
8. Technological Risks
9. Market Risks
10. IPR/legal Risks
11. Financial/Management risks factors
12. Environmental risks factors

Discussion of the Priority Map for the project

All risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act.
Considering Market risk factors a potential intervention should be considered to act on the market target by adapting the value proposition and prospect new customers. For Technological risks a potential intervention could be a re-evaluation of technology and further optimisation to match/outperform new benchmark. The Legal risks present that interoperability tests mix know-how, data and IP from various entities, a potential intervention should be to integrate those aspects from the beginning of the project in the contracts and by establishing NDAs.
In case of Financial risk factors, some solutions should be to work on business plan, increase turnover through marketing and commercial actions and adapt manpower to actual activity. For environmental/regulatory risk factors a potential solution should be monitor and eventually contribute to the evolutions of standards.

3.13 **KER NO.13** - CONSULTATION ON COSTS AND BENEFITS OF GRID CONNECTIONS AND REGULATED REMUNERATION OF TSOS FOR GRID CONNECTIONS

KER leading partner: Deutsche WindGuard (DWG)

3.13.1 CHARACTERIZATION OF THE RESULT

Consultation on Cost and Benefits of Grid Connections between Converter Stations in the German EEZ and Regulted Remuniration of TSOs for Grid Connections between Converter Stations in the German EEZ	
Problem	• German Federal Maritime and Hydrographic Agency (BSH) perspective: Within the scope of the German marine spatial planning (FEP), higher degree of redundancy in offshore grid through the connections between converter stations in the German EEZ is investigated: ➢ as mitigation measure to reduce the offshore wind energy not supplied due to a grid outage; ➢ to reduce the compensation payments (and thus the consumer tariffs) from the TSO to the OWF operators in case of grid outage. • **TSO** perspective: It is not certain if additional grid costs (CAPEX & OPEX) for the connections between converter stations could be covered through the grid tariffs/allowed by the National Regulatory Authority (NRS).
Alternative solution	BSH has conducted pre-investigations on the potential connections between converter stations in the German EEZ but the analysis was based on rough estimations and assumptions. Our analysis is more detailed using scientific input and knowledge gained within the PROMOTioN project.
Unique Selling Point USP - Unique Value Proposition UVP	BSH contracted DWG for the investigation of potential costs and benefits from the connection of converter stations in the German EEZ due to their participation in the PROMOTioN project and the technical knowledge on grid developments that was gained from the project, the deep knowledge on the grid connection systems of the German OWFs and the professional competence in the field of offshore wind. DWG has conducted a high fidelity simulation using public available results from PROMOTioN which gives high quality and detailed results for the possible connection of offshore converter stations in the German EEZ.
Description	The solution is service/consultancy. How: Data and publicly available results from PROMOTioN are utilised to conduct a reliability analysis of the main grid components and in combination with calculated power time series to determine the benefits, in terms of avoided energy loss, and the costs (CAPEX &OPEX) incurred through connections between converter stations. The assessment is accurate and show more precisely the benefits for the German consumers.
"Market" – *Target market* (Customers)	Within Germany's current policy of increasing the installed capacity of offshore wind up to 15 or even 20 GW by 2030 our primary target market is German ministerial bodies (e.g. BSH, BMWi, etc.) for the costs and benefits of potential grid connections between converter stations in the German EEZ.
Early Adopters	German **TSO**, German NRA (BNetzA)
"Market" - Competitors	DWG is a consultancy with a 20 year experience in the field of wind energy and can provide scientific, technical and operational services to investors and developers, manufacturers, decision makers in ministries and industry in all facets of wind energy. Competitors are other European consultants with more engineering focus or/and expertise in energy economic aspects and with more experience in certain countries.
Go to Market – Use model	Selling services to potential customers such as OWF operators, other European TSOs, ministerial and regulatory bodies, technical and standardisation bodies and business associations.

	Also, visibility is gained through communication of results in meetings with customers, conferences, workshops, scientific publications, presentations to relevant Working Groups such as AK (Arbeitskreis) organised by SOW (Offshore Wind Foundation).
Go to Market – IPR	DWG has not developed any patent and uses only publicly available results from PROMOTioN therefore, there are no IPR issues
Go to Market – IPR	DWG has not developed any patent and uses only publicly available results from PROMOTioN therefore, there are no IPR issues
Go to Market	Actual offshore development phase.

KER's Exploitation Form					
Selected route		**Implementing actor**	**Yes**	**No**	**Remarks**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	x		We already exploit our results for consulting German ministerial bodies
		A group of partners		x	
	Contract research (new contracts signed by the research group with external clients)	A partner		x	Not planned
		A group of partners		x	
	A new research project (application to public funded research programmes)	A partner		x	
		A group of partners	x		It's very possible to apply within a consortium for national and European research projects
	Implementation of a new university - course (Note that a training course is a service)	A partner		x	
		A group of partners		x	
		A new partnership		x	
INDIRECT USE	Transfer of ownership (IPR)	A partner		x	
		A group of partners		x	
	Licensing IPR	A partner		x	
		A group of partners		x	
	Development of a new legislation/standard	A partner		x	
		A group of partners		x	
	Spin- off	A partner		x	
		A group of partners		x	
		By assignment		x	
		By licensing		x	
	Other (please describe)	A partner	x		Presenting and discussing our results from PROMOTioN with national and international Stakeholders (e.g. ministries, TSOs, agencies, etc.)

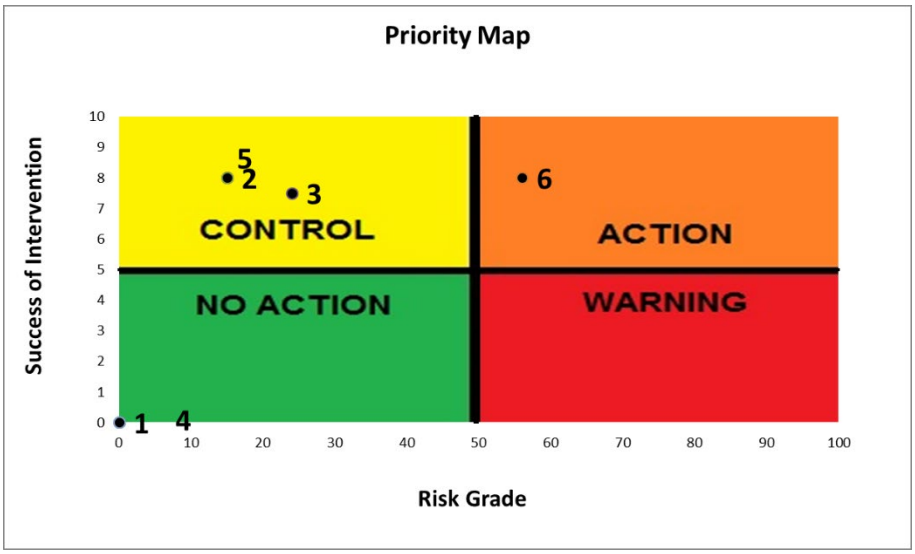
3.13.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	We have already started the Exploitation of Results: • We will continue consulting the German federal maritime and hydrographic agency (BSH) for the potential connections of offshore converters in the German EEZ by applying our results from PROMOTioN (till end of 2020). • We have been already contracted by the German Federal Ministry of Economic Affairs and Energy (BMWi) to investigate the impact of possible cross-border projects, under the European collaboration in the North and Baltic Sea, on the German regulatory framework (till 2022). • We will continue communicating our results within PROMOTioN by presenting them to key Stakeholders (ongoing).
Roles	Deutsche WindGuard GmbH in a joint consortium with other consultants
Milestones	The company's standard methods will be used to monitor and evaluate our services: • Presentation of project results (e.g. in workshops, etc.) and services to industry partners (ongoing activity) • using the project results to other services/consult our customers (ongoing activity)
Impact in 3-year time	We expect to close more contracts soon for consulting different customers on technical and regulatory issues of offshore wind market and therefore, create one extra position within our group.
Financial costs	The costs for implementing the planned activities are already covered by our customers (BSH, BMWi) who has contracted us to carry out the studies. Approximately 100 000 Euros/a revenue is estimated from consulting services.
Revenues	There are no additional costs. The costs for the research were covered by PROMOTioN and the service is already provided to the customers.
other sources of coverage	No additional financial sources are needed.

3.13.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
2	**Technological Risk Factors**	***3***	***5***	**15,0**		***8***	**120,0**
	Worthless result: better technology/methodology exists.	*3*	*5*		Re-evaluation of methodology and further optimisation to match/outperform new benchmark	*8*	
3	**Market Risk Factors**	***4***	***6***	**24,0**		***8***	**180,0**
	Exploitation disagreement: partners on the same market.	*5*	*7*		discuss exploitation proposals and ensure that parallel exploitation is beneficial and in the interest of marketing the technology /methodology	*8*	
	Nobody buys the product. Rejected by end-users.	*3*	*5*		change to another market	*7*	
5	**Financial/management Risk Factors**	***3***	***5***	**15,0**		***8***	**120,0**
	Weak exploitation: Inadequate business plan	*3*	*5*		revision of exploitation plan and market research and relaunch of methodology/service	*8*	
6	**Environmental/regulatory Risk Factors**	***7***	***8***	**56,0**		***8***	**448,0**
	Influence of laws and regulations.	*7*	*8*		thorough investigation of the laws and regulations constantly to ensure that the methodology/service meets the customer's needs	*8*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Environmental risk factors present a high-risk grade with a high probability of success, for the remedy action defines a situation where there is the need for an immediate action to ensure exploitation (action).
A possible intervention could be the investigation of the laws and regulations constantly to ensure that the methodology/service meets the customer's needs.

The Partnership and IPR/legal risk factors should be filled in the Risk Matrix tool in order to evaluate the risk level and to find a possible intervention.

The Technological, Market and Financial/Management present some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act.
Considering the Technological risks should be re-evaluated the methodology and further optimisation to match/outperform new benchmark. Considering the Market risks should be discussed the exploitation proposals and ensured that parallel exploitation is beneficial and in the interest of marketing the technology /methodology. In case of Financial/Management risk factors, should be reviewed the exploitation plan and market research and relaunch of methodology/service.

3.14 **KER NO.14** - MECHANICAL DIRECT CURRENT CIRCUIT BREAKERS

KER Leading Partner: Mitsibushi Electric Europe

3.14.1 CHARACTERIZATION OF THE RESULT

Mechanical Direct Current Circuit Breaker (DC CB)	
Problem	A cost effective solution to isolate fault in a multi terminal HVDC system do not exists that helps continue operation of healthy part of the network. This is the key technological barrier for realising multi terminal HVDC, which can interconnect different national electricity networks and renewable energy sources where an HVAC solution is not feasible.
Alternative solution	The vast majority of the existing HVDC systems are point-to-poink links in which fault in the DC side is cleared by the circuit breaker in the AC side and thus HVDC CB is not required. The HVDC CBs are required for the multi-terminal network in order to isolate the faulted line from the healthy line. The fault can be cleared by the active current injection HVDC CB, which Mitsubishi develops and the alternative solution is the hybrid HVDC CB which uses the power electronics.
Unique Selling Point USP - Unique Value Proposition UVP	We assume the users will desire the offshore platform to be compact and low cost. The following solution can solve this issue. - Components of the mechanical HVDC CB can be placed in an insulating gas inside the earthed enclosures with pressure (GIS type) that helps to realize the HVDC CB, which will use small foot print compared to an AIS type and the offshore platform can be made significantly compact. Also, if the HVDC CB is made with a GIS type, it can be downsized together with the other switch gear (e.g. DS, ES). Regarding the DC-GIS, we have a technology that is extensively proven by the only one actual operational experience in the world in Japan. The other advantage for the mechanical HVDC CB is as follows: 1) Robust design with high, long-term reliability Individual subcomponents used in the mechanical DCCB have been extensively proven in well-established AC applications. Combined with the low part-count, this results in a reliable and robust DC CB design. 2) Low conduction losses - Physical matalic contact in the CB results in lower losses and high efficiency HVDC transmission, contrasting with the use of semiconductors. 3) Low cost and small footprint Inexpensive mechanical contact less susceptible to operating conditions is used in contrast to interruption methods using semiconductor elements. Without the need for cooling systems, low cost small footprint protection facilities for HVDC transmission can be realized.

Description	The fundamental performance of an AIS type 160-200 kV double break mechanical HVDC CB prototype has been verified in WP10 demonstration test. ・It has successfully interrupted the peak current of 16 kA that reproduces a fault in a real system within 7 ms. ・Verified that it has a capability to interrupt the current ranging from 0.2 kA to 16 kA in both directions with equal voltage distribution among each interrupter units. ・Verified that the MOSA can dissipate the energy up to few MJ. DCCBs of different voltage, current ratings and configuration (AIS/ GIS type) can be developed to meet customer requirement and Mitsubishi will continue development based on market situation .
"Market" – *Target market* (Customers)	Future HVDC grid including onshore and offshore. The customer will be typically relevant TSOs and grid developers. And the technology could potentially be extended to MVDC system.
Early Adopters	European market as it's advanced in HVDC and offshore development.
"Market" - Competitors	ABB: Hybrid HVDC CB Strengths: Suppression of the amount of the MOSA dissipation energy along with the fast current interruption. Weakness: High cost, indoor usage, cooling systems and air conditioning. SCiBreak: VARC DCCB Strengths: High-speed interruption can be achieved in spite of a mechanical type. Weakness: No experience for the high voltage. Siemens: Full-bridge convertor Strengths: DCCB is not required because the fault can be controlled by the convertor. Weakness: High cost and consume large space.
Go to Market – Use model	Cannot answer.
Go to Market – IPR	Cannot answer.
Go to Market – IPR	Cannot answer.
Go to Market	Cannot answer.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	X	
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner		
		A group of partners		
	A new research project (application to public funded research programmes)	A partner		
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

3.14.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	
Roles	MELCO Technical development, product development, manufacturing
Milestones	Planning a HVDC CB testing at Kema lab in September 2020
Impact in 3-years time	
Financial costs	
Revenues	
other sources of coverage	

3.15 **KER NO.15** - HVDC PROTECTION INTELLIGENT ELECTRONIC DEVICE

KER Leading Partner: Mitsibushi Electric Europe

3.15.1 CHARACTERIZATION OF THE RESULT

HVDC Protection intelligent electronic Device (IED)	
Problem	HVDC equipment, including protection and control, is typically supplied by a single supplier for a given project, with little or no inter-operability. As systems expand from point-to-point to multi-terminal solutions, multi-vendor compatible protection solutions will be required in order to maintain competition and inovation.
Alternative solution	This has not been demonstrated within Europe so far.
Unique Selling Point USP - Unique Value Proposition UVP	Multi-vendor compatible protection device
Description	Through use in WP9, our IED has been shown to be compatible with other IEDs and allowed inter-operation in conditions such as back-up protection, etc.
"Market" – *Target market* (Customers)	Developers of multi-terminal HVDC systems
Early Adopters	
"Market" - Competitors	Currently all main HVDC manufacturs would be capable of providing protection and control equipment, as is industry standard. However, interopability has not yet been demonstrated
Go to Market – Use model	Manufacturing and sale to multi-terminal HVDC system developer
Go to Market – IPR	
Go to Market – IPR	
Go to Market	

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	X	
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner		
		A group of partners		
	A new research project (application to public funded research programmes)	A partner		
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

3.16 **KER NO.16** - DC GRID TECHNICAL COMPETENCE BUILD UP

KER Leading Partner: Svenska kraftnät (Svk)

3.16.1 CHARACTERIZATION OF THE RESULT

DC grid technical competence build up	
Problem	Lack of inhouse knowledge and access to information regarding current technical status for DC grid technology.
Alternative solution	1) Ignore new technology and continue with HVDC p-t-p connection and AC transmission. 2) Hire consultants
Unique Selling Point USP - Unique Value Proposition UVP	Through having inhouse knowledge, SvK can develop their own functional specifications and associated documentation for possible future HVDC projects should there be stakeholder inquiries or SvK sees potential for areas or projects with DC grid. In the right situation, DC grid concepts can offer lower investment costs and higher flexibility.
Description	Through PROMOTioN SvK has been given many opportunities for observations, collecting information and gaining knowledge on the technology status for DC grid and HVDC development, Meshed offshore grid development strategies and HVDC protection equipment and protection strategies. This is shared knowledge of information between stakeholders with different goals: academica, TSOs and manufactures. PROMOTioN has also given SvK a better overview of the available HVDC expertise in Sweden and elsewhere
"Market" – *Target market* (Customers)	The knowledge gained is intended for internal use within departments in SvK, e.g. as input for longterm grid planning and if relevant in relation to stakeholder enquiries.
Early Adopters	The early adopters are expected to be the planning department of SvK.
"Market" - Competitors	External experts on HVDC technology
Go to Market – Use model	SvK has participated in several PROMOTioN events and has taken the learnings from these events back to its internal organisation where information on new knowledge and contact persons has been shared.
Go to Market – Background IPR	The background is identical to what was agreed in the Consortium Agreement, not applicable for SvK
Go to Market – Foreground IPR	This foreground is shared between different stakeholders. What information SvK has gained has been open source and not protected by IPR.
Go to Market	The increased DC grid technology knowledge is available in SvK straight away, and will contine to increase during the PROMOTioN project. When the knowledge will be used for specific projects will rely on technology and cost development, if potential is identified. Possible drivers behind this need can be higher density of interconnection and establishment of offshore wind power, which are both relevant issues for Sweden.
KER's Exploitation Form	

(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		X
		A group of partners		X
	Contract research (new contracts signed by the research group with external clients)	A partner		X
		A group of partners		X
	A new research project (application to public funded research programmes)	A partner		X
		A group of partners		X
	Implementation of a new university - course (Note that a training course is a service)	A partner		X
		A group of partners		X
		A new partnership		X
	Other: Knowledge enhancement and build-up	A group of partners	X	
INDIRECT USE	Transfer of ownership (IPR)	A partner		X
		A group of partners		X
	Licensing IPR	A partner		X
		A group of partners		X
	Development of a new legislation/standard	A partner		X
		A group of partners		X
	Spin- off	A partner		X
		A group of partners		X
		By assignment		X
		By licensing		X
	Application of knowledge in a alternative HVDC space	A partner		X
		A group of partners		X

3.16.2 EXPLOITATION ROADMAP

Exploitation roadmap	
Actions	Buiseness as usual, but spread the word about the PROMOTioN project, the findings and lessons learnt by Svk employees that have attended PROMOTioN events
Roles	Experts in HVDC at Svk will handle internal dissemination. Some cooperation with other European TSOs is likely in addition to cooperation through CIGRE, ENTSO-e and other European and international foras of cooperation on grid development and regulation.
Milestones	The gained knowledge and competence will be continually utilized and not related to any predefined milestones. It can however be used in relation to long term system development plans shuld Svk see a need for the technology. It can also be relevant if projects are initiated by stakeholders or other European TSOs.
Impact in 3-years time	Direct impact is difficult to foresee and quantify, as exploitation of knowledge is normally not direct. The knowledge may however be exploited with regards to ongoing projects such as the SouthWest Link project in Sweden.
Financial costs	Not applicable as there are no plans for any dedicated activity, other than knowledge sharing that are already part of Svk employee job descriptions.
Revenues	N/A. Could possible reduce grid tariffs longterm if the knowledge of HVDC technology is used in socio-economic profitable projects
other sources of coverage	No other source of coverage is needed.

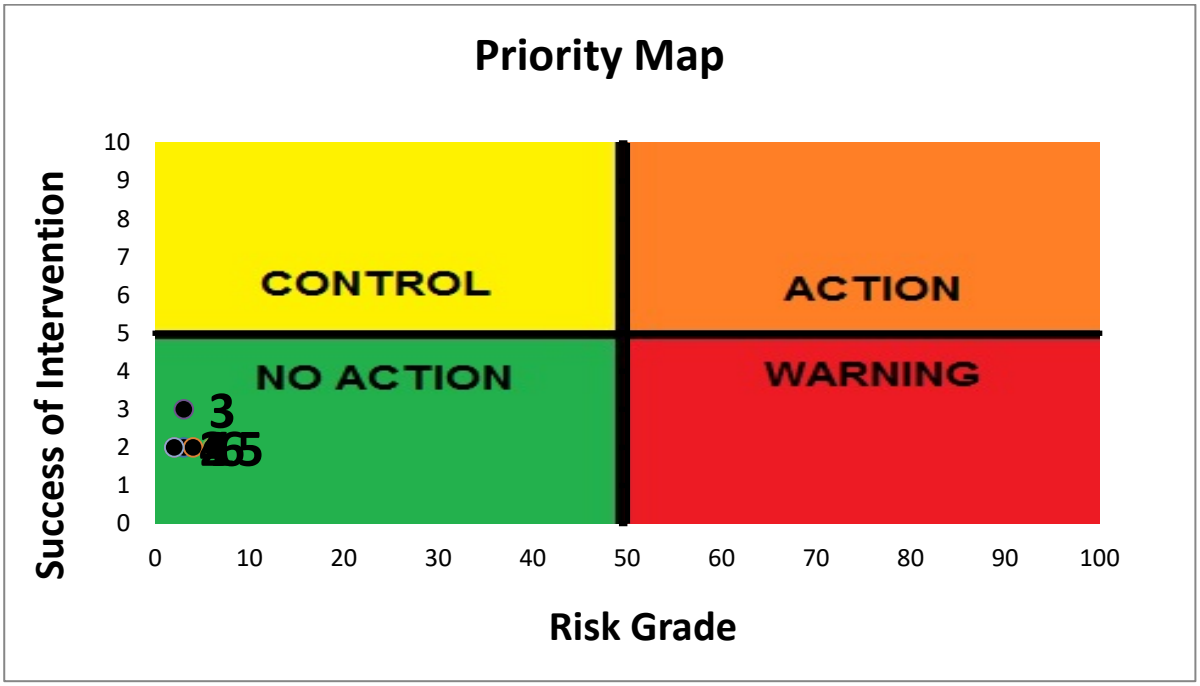
3.16.3 RISK MATRIX

Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
Partnership Risk Factors	***2***	***2***			***2***	
Disagreement on ownership rules	*2*	*1*		Legal mediation of downership disputes and patent review		
Disagreement on further investments: some partners may leave.	*2*	*2*	**3,0**	initiate consortium meeting toexplain usage issues and redefine roadmap of exploitation		**6,0**
				maintain communication with exiting expert and organise hand-over and training	*2*	
Technological Risk Factors	***1***	***2***			***2***	
Worthless result: better technology/methodology exists.	*1*	*2*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*2*	
Result aiming at replacing existing and well entrenched technologies	*1*	*2*	**2,0**	redesign of valve configuration to enhance range of device	*2*	**4,0**
Result aiming at replacing existing and well entrenched technologies				correctly assess existing market technologies and assess performance and ability to penetrate market through replacement in exisiting applications		

Market Risk Factors	***1***	***3***			***3***	
Exploitation disagreement	*1*	*3*	**3,0**	discuss exploitation proposals and ensure that parappel exploitation is beneficial and in the interest of marketing the trechnology	*4*	**9,0**
difficulty in market penetration/customer reception and acceptance of technology				additional market studies, customer surveys and assessment of product shortfalls	*2*	
IPR/legal Risk Factors	***1***	***2***			***2***	
Legal problems: proceeding against us.	*1*	*2*	**2,0**	Better understanding of applicable legal restrictions	*2*	**4,0**
Financial/management Risk Factors	***2***	***3***			***2***	
weak exploitation of the material	*2*	*3*	**6,0**	Possible revision of exploitation plan	*2*	**12,0**
Environmental/regulatory Risk Factors	***2***	***2***			***2***	
Influence of laws and regulations.	*2*	*2*	**4,0**	assessment of legal/regulatory requirements	*2*	**8,0**

Comment on Risk: The main risk we face of realising our KER is that the limited effort, which we have done, in the PROMOTioN project is wasted due to failure to utilize the competence that has been build up. It is very difficult for us to further quantify this conclusion (risk).

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

All risk factors are considered to be low and requires little follow up. Should it be needed, intervention should be followed up on, given that the project team thinks it is probable that it will help realise the exploitable result.

3.17 KER NO.17 - DC CIRCUIT BREAKER WITH PARALLEL CAPACITOR

KER Leading Partner: University of Aberdeen

3.17.1 CHARACTERIZATION OF THE RESULT

DC Circuit Breaker with Parallel Capacitor	
Problem	The commercial Circuit Breakers are considered too expensive, since total cost is estimated at tens of £ millions. They are slow with the reported opening time of 2-8ms. They contain energy absorbing elements (which do not exist with conventional AC breakers) and hence occupy much larger space. Compared with the traditional AC CBs**,** DC CB**s** are an order of magnitude more expensive.
Alternative solution	• The hybrid DC CB is considered the best performing DC CB. However, it includes large semiconductor valve which has high costs. • The second alternative is active injection DC CB, which has slower opening speed and higher energy dissipation.
Unique Selling Point USP - Unique Value Proposition UVP	A new DC CB topology has been studied and experimentally demonstrated on low power prototype in PROMOTioN project. The initial experimental results have indicated that this DC CB has many attractive features: fast opening speed and potentially lower cost. The opening speed on laboratory prototype was around 1ms with gradual current reduction beginning at 0.4ms. The device uses solely mechanical components and therefore cost is expected to be low.
Description	This new technology has been tested in the laboratory and results are presented in the following articles: [1] D.Jovcic "Fast Commutation of DC Current into a Capacitor Using Moving Contacts" IEEE transactions on power delivery, early access 2019, DOI: 10.1109/TPWRD.2019.2919725; [2] D. Jovcic, "Series LC DC Circuit Breaker", IET High Voltage, vol. 4 no. 2, pp. 130-137, Jun. 2019., DOI:10.1049/hve.2019.0003
"Market" – *Target market* (Customers)	The market includes all future DC grids and multiterminal HVDC systems. Medium voltage DC systems would also be big market. DC grids do not exist at present but there is lot of research and development worldwide. One particular example would be North Sea DC grid for the integration of large offshore wind energy. Medium voltage DC systems are studied for the applications with collection systems for various renewable energy sources. The DC distribution grids have been studied for example for marine propulsion and integration of energy storage.
Early Adopters	The early adopters would be demonstration projects for DC circuit breakers. Also, research demonstration projects in various research laboratories might be interested in adopting the topology. The early adopters are likely to be applications at lower (medium) voltage levels. As an example railway systems use 1.5-3kV DC systems and they need many DC Circuit Breakers.

"Market" - Competitors	The competitors are all manufacturers of DC CB**s** like: • ABB; • Mitsubishi; • SCiBreak; • Chinese manufacturers Most of these competitors are also part of the PROMOTioN project
Go to Market – Use model	We have already published a number of papers and made presentations. A patent application has already been filed. There are multiple options for exploitation including licensing, or further demonstration through joint venture or larger demonstration projects. A spin-out company might be one option. At present all options are open. The directions will depend on the ongoing testing results and the results form patenting.
Go to Market – IPR	An international patent application was made in June 2018. No other PROMOTioN partner has brought any background in relevance to this exploitable result.
Go to Market – IPR	The foreground belongs solely to University of Aberdeen.
Go to Market	There will be several years of further demonstration to gain confidence in the technology. This can be accelerated if there is early licensing to a manufacturer. A funding is being sought to develop technology further and to demonstrate at higher power levels.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option) all possible options to be considered are indicated below				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		
		A group of partners	x	
	Contract research (new contracts signed by the research group with external clients)	A partner		
		A group of partners		
	A new research project (application to public funded research programmes)	A partner	x	
		A group of partners	x	
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner	x	
		A group of partners	x	
	Licensing IPR	A partner	x	
		A group of partners	x	
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner	x	
		A group of partners	x	
		By assignment	x	
		By licensing	x	
	Other (please describe)			

3.17.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	Seeking support for further development of technology. A proposal is being prepared for a 3-year research project with EPSRC titled ”Fast mechanical DC Circuit Breakers”. In the last 3 months of the PROMOTioN project the new project proposal will be finalised including the funding required. The project will be evaluated by funding agency within 6 months after PROMOTioN.
Roles	Aberdeen is key and sole driver of technology.
Milestones	Milestone 1 is new project set up. If approved the new project is expected to begin around 2021.
Impact in 3-year time	Potential establishment of new small company or licensing.
Financial Costs	Realisation of prototype and further development and scaling of technology. 3-years project around £500k.
Revenues	Revenues from funding agencies. Profits are not expected in first 3 years.
Other Sources of coverage	Research council funding of related research topics.

3.17.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***5***	***1***	**5,0**		***3***	**13,3**
	Disagreement on ownership rules	*5*	*1*		Legal mediation of ownership disputes and patent review	*3*	
	Industrialization at risk: a partner declares bankruptcy.	*5*	*1*		Initiate consortium meeting to explain usage issues and redefine roadmap of exploitation	*3*	
	Industrialization at risk: a partner declares bankruptcy.	*5*	*1*		Maintain communication with exiting expert and organise hand-over and training	*2*	
2	**Technological Risk Factors**	***7***	***4***	**24,4**		***3***	**73,3**
	better technology emerges	*10*	*4*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*2*	
	limited market (flow limitations)	*7*	*2*		Redesign of valve configuration to enhance range of device	*4*	
	valves aim to replace existing mechanical counterparts	*3*	*5*		Correctly assess existing market technologies and assess performance and ability to penetrate market through replacement in existing applications	*3*	
3	**Market Risk Factors**	***4***	***3***	**10,0**		***4***	**35,0**
	Exploitation disagreement	*4*	*2*		Discuss exploitation proposals and ensure that parallel exploitation is beneficial and in the interest of marketing the technology	*2*	
	difficulty in market penetration/customer reception and acceptance of technology	*4*	*3*		Additional market studies, customer surveys and assessment of product shortfalls	*5*	
4	**IPR/legal Risk Factors**	***5***	***4***	**20,0**		***6***	**120,0**
	competitors replicate technology	*5*	*4*		Stricter control in in patent usage and aggressive pursuit of legal action	*6*	

5	**Financial/management Risk Factors**	***3***	***5***	**15,0**		***6***	**90,0**
	weak exploitation of the material	*3*	*5*		Revision of exploitation plan and market research and relaunch of product	*6*	
6	**Environmental/regulatory Risk Factors**	***4***	***7***	**28,0**		***5***	**140,0**
	not in compliance with regulations	*4*	*7*		A8ssessment of legal/regulatory requirements and alteration of product to comply	*5*	

Priority map of Exploitable result

Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Environmental risks present a situation between Control and No action, where is a low risk grade with a medium probability of success of the planned remedy.

The Partnership, Technological and Market risk factors present a low-risk grade and a low probability of success for the remedy, it is a situation does not call for immediate action (no action).

The IPR/legal, Financial/Management risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act. The IPR/legal risks should be stricter controlled in the patent usage and aggressive pursuit of legal action. Considering the Financial/Management risk factors should be reviewed the exploitation plan, the market research and the relaunch of product.

3.18 **KER NO.18** - KNOWLEDGE TRANSFER TO THE CENELEC TC8X WG06

Leading Partner: RTE

3.18.1 CHARACTERIZATION OF THE RESULT

Knowledge transfer to the Cenelec TC8X WG06	
Problem	• Experiences with the design, protection and operation of high voltage Direct Current Grid (DCG) is limited as no such grid exists to date in Europe and there are only very few such systems in operation worldwide. • The lack of standards regarding DCG is perceived to be a hurdle for stakeholders (customers – e.g. TSOs, developers-, manufacturers, academia and consultants) to implement such projects in real life. Standards would contribute to a common understanding between stakeholders on the design- and operating principles which is needed to develop such systems. As a consequence, existing technological alternatives are mainly considered so far (e.g. point-to-point links) which are safe and mature technologies.
Alternative solution	The definition of standards or grid codes does not strictly rely on PROMOTioN, as parallel activity to standardize definitions, layout and operation of **DCG** is conducted in CENELEC TC 8X/WG 06 (European standardization body). The standards made by CENELEC represent consensus of a broad variety of stakeholders such as manufacturers, TSOs, Institutions, Academia and other organisations. The CLC/TS 50654-1 and -2 represent Guidelines to the functional specifications for HVDC Grid Systems in Europe. Being connected with that work has been important for PROMOTioN. The work of CENELEC TC 8X/WG 06 is continued at IEC/TC 115/WG 15. Further DCG related standardisation projects are ongoing or being planned at IEC. Any action taken in the same direction than CENELEC TC 8X/WG 06 is expected to contribute and accelerate the standardization process this body is undertaking. This is all the more important since standardization activities are also performed for high voltage DCG in other areas of the world. Simulation results obtained within PROMOTioN (e.g. regarding protection strategies or wind park interactions) mostly based on a 5-terminal benchmark, as well as testing of DC breakers and IED have led to results publicly available, which illustrate and validate a variety of the CENELEC guidelines. The feedback provided by PROMOTioN, based on those simulations and tests, was hopefully useful to support the standardization activities undertaken by CENELEC TC 8X/WG 06.
Unique Selling Point USP - Unique Value Proposition UVP	PROMOTioN has the capability to perform detailed studies, demonstrations and testing to confirm the operational principles of equipment and solutions described by the functional specifications of CENELEC TC 8X/ WG 06. In this context, PROMOTioN provided valuable technical support to the work of CENELEC TC8X WG06.
Description	PROMOTioN has contributed to the existing processes at CENELEC TC8X WG06 by, e.g.: • Investigating specific technical topics in detail, such as: - Simulation of DCG protection concepts and techno-economical comparisons - Demonstration of the fault clearing behaviour and capability of different types of HVDC Circuit Breakers - Demonstration of Gas Insulated DC Switchgear • Providing technical support to CENELEC TC 8X/WG 06 by an extensive review of its guidelines and a set of proposals for improvement • Providing a report with an extensive survey of existing standards relevant for DCG • Carrying out a dedicated workshop with CENELEC to discuss open topics in field of Control & Protection standardization for DCG Specific attention was put on the CENELEC TC 8X/WG 06 guidelines with an extensive review of the document and several comments and proposals for improvement (recommendations) which have been regarded by CENELEC TC 8X/WG 06.

	Finally, PROMOTioN provides a wide range of results established by various types of stakeholders (e.g. public deliverables).
"Market" – *Target market* (Customers)	Standardisation projects such as CENELEC. The work of PROMOTioN as well as CENELEC is intended to facilitate the development and execution of DCG needed to meet the EU green deal targets. Immediate application will be done by European **TSO**s and project developers with an interest in **DCG** or **HVDC**, and any **HVDC** technology provider willing to propose technology solutions to the European market.
Early Adopters	Technical solution providers, system planners and investors as well as standardisation projects worldwide. In the context of the EU Horizon 2020 project, PROMOTioN's feedback has been given directly to CENELEC. As this action is purely technical, there are no lobby organisations or other partners, except those already involved in PROMOTioN and the CENELEC standardisation work, that are involved in the knowledge transfer.

"Market" - Competitors	Early development of real DCG technologies is a key factor of competitiveness for the European economy and for securing jobs in the mid and long term. A major risk for the European DCG developments is to fall behind other regions in the world (e.g. Asia), resulting in reduced competitiveness of the European industry and finally creating dependencies for essential infrastructures on foreign suppliers.
Go to Market – Use model	Knowledge transfer between PROMOTioN and CENELEC was ensured during the project period through a dedicated liaison between the two organisations. This includes comments and recommendations from PROMOTioN to CENELEC guidelines.
Go to Market Background – IPR	No background IPR for RTE was listed in the Consortium Agreement
Go to Market Foreground – IPR	The Foreground generated in PROMOTioN to support the knowledge sharing related to DCG is shared among the partners involved in the project. RTE has no specific foreground IPR.
Go to Market - Which is the time to market?	The exchange of information with CENELEC was already performed during the project period. The follow up of the knowledge transfer will be conducted by CENELEC and subsequently IEC (e.g. IEC TC 115/WG 15).

KER's Exploitation Form				
(how the KER will be further exploited				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		X
		A group of partners		X
	Contract research (new contracts signed by the research group with external clients)	A partner		X
		A group of partners		X
	A new research project (application to public funded research programmes)	A partner		X
		A group of partners		X
	Implementation of a new university - course (Note that a training course is a service)	A partner		X
		A group of partners		X
		A new partnership		X
INDIRECT USE	Transfer of ownership (IPR)	A partner		X
		A group of partners		X
	Licensing IPR	A partner		X
		A group of partners		X
	Development of a new legislation/standard	A partner	**X**	
		A group of partners	**X**	
	Spin- off	A partner		X
		A group of partners		X
		By assignment		X
		By licensing		X
	Other (please describe)			X

3.18.2 EXPLOITATION ROADMAP

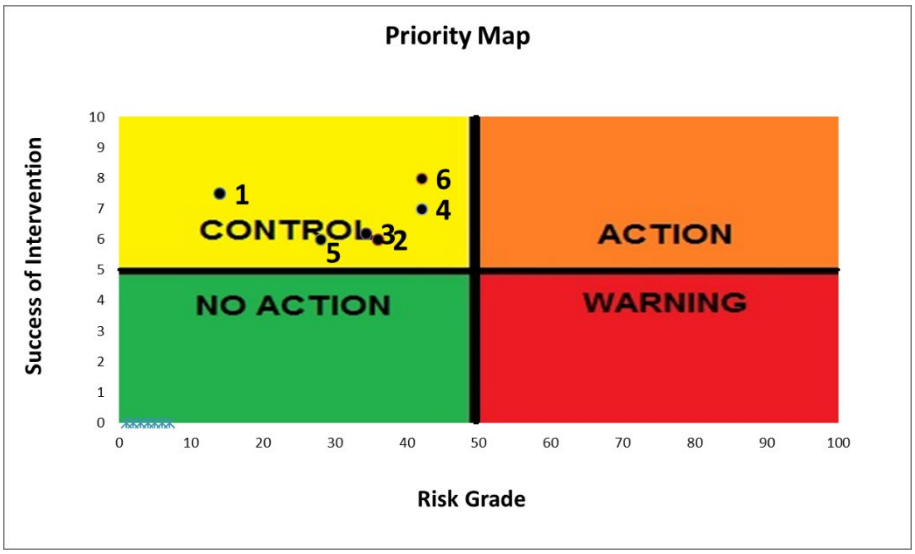
Exploitation Roadmap	
Actions	Review and comments were already submitted to CENELEC TC 8X/WG 06 which has approved most of them. The continuation of using the results of PROMOTioN is ensured by the working principles of the standardisation bodies, e.g. CENELEC and IEC.
Roles	Experts in **HVDC** at RTE, already contributing to CENELEC, contributing to establish guidelines toward DC grids.
Milestones	Standardization is an ongoing process. The CLC/TS 50654-1 and -2 have passed voting at CENELEC with 100% positive vote.
Impact in 3-year time	The work of CENELEC TC 8X/WG 06 is continued at IEC/TC 115/WG 15 with an expected worldwide impact. The standard itself is seen as a required "enabler" for **HVDC** grids.
Financial costs	Ongoing activities for RTE at CENELEC represent about 10 person-days a year (no change with respect to the situation before the Exploitation of Result).
Revenues	The standardization activity (including contribution to CENELEC) is a well-established expertise activity at RTE (cf. IEC, CIGRE…). No extra revenue is needed for this as no extra load is foreseen due to this Result.
Other sources of coverage	No other source of coverage is needed.

3.18.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***4***	***4***	**14,0**		***8***	**105,0**
	Disagreement on further investment: company decision not to invest in standardization activities related to HVDC anymore.	*5*	*2*		The contribution to CENELEC is already provided, so if this risk is confirmed no major impact is foreseen, nor mitigation action is required. There was a collective effort in PROMOTioN to support CENELEC; if some management decision results in a member abandoning its contribution to CELENEC, some other can keep up with spreading the word.	*8*	
	Industrialization at risk: the current standardization process is frozen or abandoned.	*3*	*5*		Alternative standardization or pre-standardization bodies are also relevant to define the standards for future DCG (CIGRE,…) to which we also contribute.	*7*	
2	**Technological Risk Factors**	***6***	***6***	**36,0**		***6***	**216,0**
	Worthless result: late disclosure with respect to other standards	*7*	*5*		Since other standards (outside Europe) will need to be transposed to EU standards, those external standards will most likely have to comply with what was already agreed upon by EU stakeholders (in particular in CENELEC). No specific action to be undertaken here.	*9*	
	Worthless result: other technical alternatives are preferred to DCG	*5*	*7*		If other transmission technologies are preferred to DCG, may be some improvement on the standards can be marginally provided, but most likely with little impact. In any case, the effort put on standardisation benefits also to "classical" point-to-point HVDC solutions, so it cannot be fully "lost".	*3*	
3	**Market Risk Factors**	***7***	***5***	**34,3**		***6***	**212,8**
	Exploitation disagreement: partners with divergent interests (different technological options).	*3*	*8*		The CLC/TS 50654-1 and -2 is consequently technology neutral allowing maximum flexibility for technological development and competition.	*8*	
	Nobody buys the product. Nobody needs it.	*8*	*5*		Lobbying actions can be undertaken to valour the benefits of a DCG. Furthermore, the standards developed with CENELEC are also relevant to regular HVDC links	*7*	

	Nobody buys the product. The standard results in too expensive (as it adds extra costs).	*8*	*3*		The CLC/TS 50654-1 and -2 is consequently technology neutral allowing maximum flexibility for technological development and competition.	*7*	
	Market reduced to a single provider (some technology supplier delivers superior technology which becomes de facto the start solution).	*8*	*3*		The CLC/TS 50654-1 and -2 is consequently technology neutral allowing maximum flexibility for technological development and competition.	*1*	
	Nobody buys the product. Problems at the time of the first sales (standards proved to be ineffective, for instance)	*6*	*7*		This situation occurred in other similar projects (offshore wind farm connection through HVDC), but further investigations always made it possible to find a technical solution, which in turn shall translate into updated standards	*8*	
4	**IPR/legal Risk Factors**	***6***	***7***	**42,0**		***7***	**294,0**
	Legal problems: earlier patent exists, which limit the scope of application of the standard	*6*	*7*		Two alternative options are possible: paying license royalties when the implementation of the patent is needed (immediate action) ; or agreeing on a common pool of patents between suppliers if too many patents are limiting the implementation of a DCG. This second option will take much more time (years)	*7*	
5	**Financial/management Risk Factors**	***7***	***4***	**28,0**		***6***	**168,0**
	Lack of endorsement from top management	*7*	*4*		Better valorisation of the benefits to consider DCG in the portfolio of technical solutions for a TSO	*6*	
6	**Environmental/regulatory Risk Factors**	***7***	***6***	**42,0**		***8***	**336,0**
	Influence of laws and regulations (e.g. governance of a DCG lagging compared to technical standards)	*7*	*6*		Propose an implementation at national level first (or even a small-scale demonstrator) to consider one single system operator and therefore to avoid any governance issue	*8*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Partnership, Technological, Market, IPR/legal, Financial/Management, Environmental risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act.
Considering the partnership risks the current standardisation process would be frozen or abandoned, the standards for future DCG had to be defined. Considering Technological risk factors, in case of a late disclosure with respect to other standards, they can be implemented into EU standards.
Market introduction can be supported by lobbying actions for DCG. Furthermore, the standards developed with CENELEC can be relevant to regular HVDC links. Concerning the IPR/legal risk factors two alternative options are possible: paying license royalties when the implementation of the patent is needed (immediate action); or agreeing on a common pool of patents between suppliers if too many patents are limiting the implementation of a DCG. Considering the Financial/management risk factors, should be better evaluated the benefits to consider DCG in the portfolio of technical solutions for a TSO.

3.19 **KER NO.19** - DEVELOPING RTDS MODELS FOR MECHANICAL AND SCIBREAK DCCB, DEVELOPING GENERIC THERMAL MODEL OF A SURGE ARRESTER FOR DCCB APPLICATION

KER Leading Partner: TU Delft

3.19.1 CHARACTERIZATION OF THE RESULT

Developing RTDS Models for Mechanical and SciBreak DCCB, Developing Generic Thermal Model of a Surge Arrester (SA) for DCCB Application	
Problem	Multi-Terminal DC Networks (MTDC) network and their performances are still not, or are rarely, in operation. Interruption of fault currents is one of the key issues with respect to secure protection of these grids. Computer models for offline simulations are not always enough and therefore, models of the (direct current circuit breaker) DCCB for real time simulations will be needed. In this context, the problem is related to: How can current interruption times for different DCCBs be evaluated? Which will be the suitable approach to model the DCCB? Is it possible to develop a real time model based on if the performance of the networks that don't exist yet, can be examined for future purpose? How can the distribution of the energy in the surge arrester blocks resulting from the interrupted current be evaluated? How can the models be scaled to a higher voltage level?
Alternative solution	Alternative solution is to use simplified models. However, they do not provide all information. For instance, aggregated models can be used only for studies where the full current interruption can be examined and it is not possible to see how voltage will be distributed among different modules and what the share of energy absorption among different modules will be.
Unique Selling Point USP - Unique Value Proposition UVP	• Generic DCCB models for Real Time Digital Simulator (RTDS) simulate for MTDC networks of the future. • Thermal DCCB surge arrester model that accurately determines the hotspots in the surge arrester blocks after current interruption.
Description	RTDS models are important when performing simulations when one needs to observe the real time behaviour of a feasible MTDC network. As the model runs in real time, it is possible for the user to observe the system behaviour during cases where the current is interrupted. Possible failures of the DCCB may occur in the surge arresters as they are responsible for removing the energy released during current interruption. The temperature is not equally distributed and possible failure of one surge arrester block make cause cascade failure of the others. Therefore, early predication of weak points resulting from hot spots will be necessary in order to identify where transmission operators should pay attention and to timely propose preventive solutions. This model based on the application of Finite Element Method (FEM) analysis accurately determine the hot spots and can be used as a starting point in the selection of suitable SAs.
"Market" – Target market (Customers)	Future DC grids and multiterminal HVDC systems. In this context, the customers will be those TSOs who will have MTDC grids under their responsibility. Presumably, largest TSOs in Europe are expected to be the ones who will implement these technologies i.e. TenneT, RTE. Also Energinet (DK) and Statnett (NO) could be potential users as it is expected that they will make use of a feasible MTDC network in the North Sea.

Early Adopters	Transmission system operators will be the early adopters as in their planning they need to know how their system will act during faults. They will first and foremost contact the manufacturers that can test their equipment with our models.
"Market" - Competitors	Developers of surge arresters like Siemens, ABB and Toshiba are supposed to work on this as well driven by the need to satisfy clients demands in terms of safety and reliability of the exploitation.
Go to Market – Use model	There are two papers published on these DCCBs which are open access: 1. S. Liu, Z. Liu, J.J. Chavez, M. Popov: Mechanical DC circuit breaker model for real time simulations, International Journal on Electrical Power and Energy Systems, Volume 107, May 2019, pp. 110-119.(open access). 2. Seyed Sattar Mirhosseinia, Siyuan Liua, Jose Chavez Muro, Zhou Liu, Sadegh Jamali, Marjan Popov: Modeling a voltage source converter assisted resonant current DC breaker for real time studies, International Journal on Electrical Power and Energy Systems, Volume 117, 2020, pp. 105678. (open access).
Go to Market – IPR	There are no IPs as we have only worked on publications. The description of the modelling is in the papers explained. The papers are published and as such everyone who is highly experienced can repeat the work.
Go to Market – IPR	The foreground will be satisfied according to the Consortium Agreement. The models are openly published and thus available for all.
Go to Market	It can be used as soon as the project is completed, and all agreed results are published.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option) all possible options to be considered are indicated below				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		x
		A group of partners		x
	Contract research (new contracts signed by the research group with external clients)	A partner		x
		A group of partners		x
	A new research project (application to public funded research programmes)	A partner		x
		A group of partners		x
	Implementation of a new university - course (Note that a training course is a service)	A partner		x
		A group of partners		x
		A new partnership		x
INDIRECT USE	Transfer of ownership (IPR)	A partner		x
		A group of partners		x
	Licensing IPR	A partner		x
		A group of partners		x
	Development of a new legislation/standard	A partner		x
		A group of partners		x
	Spin- off	A partner		x
		A group of partners		x
		By assignment		x
		By licensing		x
	Knowledge competence		x	

3.19.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	After the project has finished, the models will be used by the utilities and the other partners.
Roles	TenneT: Tennet was a partner in this project and they have access to our results. They can use the models for their future plannings.
Milestones	1) real time analysis; 2) determination of SA hot spots. We can advise the user based on their request if there is any.
Impact in 3-year time	We can help TenneT to decide on projects resulting in a high societal value.
Financial costs	We do not foresee financial costs unless it is decided that the developed SA model will be suitable to be patented as software model. In case of patenting, the costs are normally estimated to ~ 20 kEuro
Revenues	If a possible patenting comes across, it should be first bought by someone so that costs are being covered (we have similar work going one. The request is in order to patent it, we should find a buyer).
Other sources of coverage	n/a

3.19.3 RISK MATRIX

	Key Exploitable Results	Importance of the risk (1 low- 10 high)	Probability of risk (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***1***	***1***	**1,0**		***8***	**8,0**
	Disagreement on ownership rules	*1*	*1*		Legal mediation of ownership disputes and patent review		
	Industrialization at risk: a partner declares bankruptcy.	*1*	*1*		initiate consortium meeting to explain usage issues and redefine roadmap of exploitation		
	Industrialization at risk: a partner declares bankruptcy.	*1*	*1*		maintain communication with exiting expert and organise hand-over and training	*8*	
2	**Technological Risk Factors**	***2***	***1***	**2,0**		***7***	**14,0**
	better technology emerges	*2*	*1*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*7*	
	limited market (flow limitations)	*2*	*1*		redesign of valve configuration to enhance range of device	*7*	
	valves aim to replace existing mechanical counterparts				correctly assess existing market technologies and assess performance and ability to penetrate market through replacement in existing applications		
3	**Market Risk Factors**	***1***	***1***	**1,0**		***3***	**3,0**
	Exploitation disagreement	*1*	*1*		discuss exploitation proposals and ensure that parallel exploitation is beneficial and in the interest of marketing the technology	*3*	
	difficulty in market penetration/customer reception and acceptance of technology	*1*	*1*		additional market studies, customer surveys and assessment of product shortfalls	*3*	
4	**IPR/legal Risk Factors**	***1***	***7***	**7,0**		***2***	**14,0**
	competitors replicate technology	*1*	*7*		stricter control in in patent usage and aggressive pursuit of legal action	*2*	
5	**Financial/management Risk Factors**	***1***	***1***	**1,0**		***3***	**3,0**
	weak exploitation of the material	*1*	*1*		revision of exploitation plan and market research and relaunch of product	*3*	
6	**Environmental/regulatory Risk Factors**	***1***	***1***	**1,0**		***3***	**3,0**
	not in compliance with regulations	*1*	*1*		assessment of legal/regulatory requirements and alteration of product to comply	*3*	

Priority map of Exploitable result

Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Partnership and Technological risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act. The Partnership risks should maintain a communication with exiting expert and organised a hand over and training. Considering the Technological risk factors the technology should be re-evaluated and further optimised to match/outperform new benchmark.

Considering Market, IPR/legal, Financial/Management and Environmental risk factors have been registered a low-risk grade and a low probability of success for the remedy, this situation does not call for immediate action.

3.20 **KER NO.20** - INCREASED KNOWLEDGE AND POSSIBLITY TO PROFIT FROM FUTURE DC GRID CONTROL AND PROTECTION TECHNOLOGIES FOR UPCOMING PROJECTS

KER Leading Partner: Equinor

3.20.1 CHARACTERIZATION OF THE RESULT

Increased knowledge and possiblity to profit from future DC grid control and protection technologies for upcomming projects	
Problem	The experience of developing HVDC is crucial for offshore wind farm developers. In order to accelerate the HVDC development at European level, the interoperability and standardisation problems must be effectively solved. Multivendor, multiterminal DC grids are important for large integration of RES to the grid. Control and protection of DC grids are important as well DC breaker technologies. Development of future DC grids requires that the multivendor HVDC projects with related DC protection technologies are available in the market.
Alternative solution	The industry continues with point to point connections and develop not optimal designs for integration of RES to grid. This approach may impact the cost-efficient development of projects, consequently offshore wind developers e.g. Equinor may not invest as the solution will not be cost efficient.
Unique Selling Point USP - Unique Value Proposition UVP	Several key aspects of HVDC MTDC control and protection technologies have been demonstated and the results are convincing. Major obstacles with DC grid control and protection have been resolved in PROMOTioN, these technologies can be implemted in upcomming DC grid projects if OEMs will develop required products. There are several DC breakers technologies demonstrated in the project, several DC protection IEDs are developed and demonstred in this project. It has been demonstared that DC grid projects can be developed.
Description	Technologies and feasability of proposed technologies with high TRL have been demonstarted. The next stage will be for the manufactures to propose and implement these technologies in upcomming DC grid projects. When the technologies have been proved to work, Equinor can incorporate them in our own offshore wind projects.
"Market" – *Target market* (Customers)	Offshore wind farm developers business unit, R&D unit in Equinor
Early Adopters	offshore wind farm developers and DC grid developers in Equinor
"Market" - Competitors	Not relevant because the project brought in collabration between 30 companies in order to develop the required technologies and close the gaps
Go to Market – Use model	The results from the project to be implemented in future projects by contracts awarded for products from OEMs (Original Equipment manufactures)
Go to Market – IPR	Not applicable
Go to Market – IPR	Not applicable
Go to Market	It might take 5 to 10 years to have the fisrt European projects with the technologies developed in PROMOTioN.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		
		A group of partners	X	
	Contract research (new contracts signed by the research group with external clients)	A partner		
		A group of partners		
	A new research project (application to public funded research programmes)	A partner		
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

3.20.2 EXPLOITATION ROADMAP

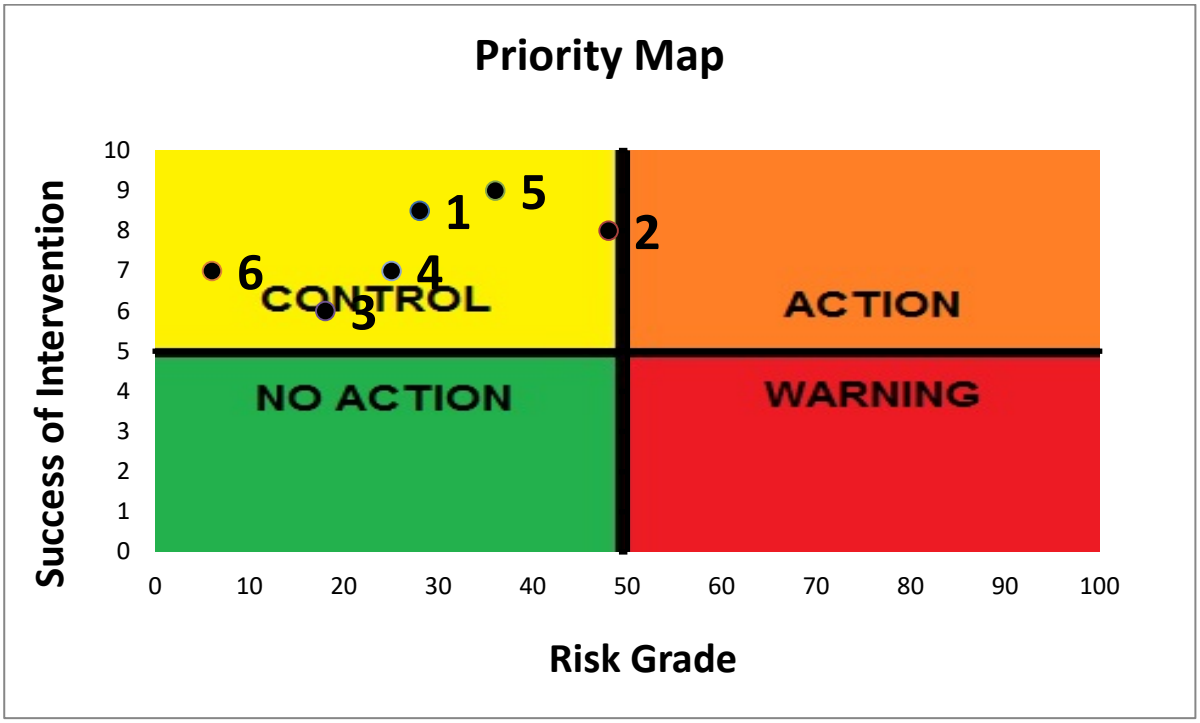
Exploitation Roadmap	
Actions	We will wait for equipment manufactures to market their products in DC grid control & Protection
Roles	Equinor will purchase possible products, ABB, Scibreak, Mitsibushi etc
Milestones	None / can not be disclosed
Impact in 3-years time	New offshore wind projects may utlize the possible products in 3-5 years time span, This will create new offshore wind project oppurtunities, the value these projects may vary with the market developments
Financial costs	Confidential, Will depend on the market development
Revenues	Confidential, Will depend on the market development
other sources of coverage	Not applicable

3.20.3 RISK MATRIX

Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
Partnership Risk Factors	***8***	***4***			***9***	
Lack of agreement between partners on standardisation	*7*	*4*	**28,0**	Experienced independent standard chairman to find best compromise. Use of revisions to improve agreement in successive publications	*9*	**238,0**
Lack of sufficient industrial representation to compile meaningful standard	*9*	*3*		Develop standard as spin-off of current activities	*8*	
Technological Risk Factors	***8***	***6***			***8***	
Standard ill-developed or out-paced by technology development and needs revision	*8*	*6*	**48,0**	Arrange standard in revisions and agree on update plan	*8*	**384,0**
Market Risk Factors	***9***	***2***			***6***	
Nobody makes use of the standard - not needed	*9*	*1*	**18,0**	Consider full revision of standard	*5*	**108,0**
Nobody makes use of the standard - not considered useful	*9*	*3*		Partners with experience to provide more transparency on justifications of the need for standard	*7*	
IPR/legal Risk Factors	***5***	***5***			***7***	
	5	*5*	**25,0**			**175**

Financial/management Risk Factors	***6***	***6***	**36,0**		***9***	**324,0**
Excessive delay in publication	*6*	*6*		Publish in versions with clear plan for revisions	*9*	
Environmental/regulatory Risk Factors	***3***	***2***	**6,0**		***7***	**42,0**
	3	*2*				

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

3.21 KER NO.21 – EFFECTIVE COMMUNICATION OF OFFSHORE TRANSMISSION PROJECT RESULTS AND FINDINGS

KER Leading Partner: SOW

3.21.1 CHARACTERIZATION OF THE RESULT

Effective Communication of Offshore Transmission Project Results and Findings	
Problem	Highly specialised technical project results and achievements are challenging to communicate to expert groups and, even more difficult, non-experts (regulators, investors, policy-makers). This is particularly true with regards to the complex field of offshore power technology. This technology will likely play a major role for the future of the energy system, but has rarely made its way into stakeholder or decision maker discussions, let alone generate attention in the media or among a wider audience. Experts engaged in developing and working with the technology usually do not possess the skills and tools to communicate the relevant results of their work to anyone beyond the immediate industry branch. However, with the threat of climate change now at the centre of public discussion, the lack of effective communication and, consequently, stakeholder and public awareness, has become a problem hindering prompt offshore grid deployment. Given the relevance of the technology for achieving the EU climate goals and realising decarbonisation, this problem is particularly pressing. It originates from different levels of knowledge about HVDC components and their operational readiness. The application of the technology is supposed to be based on current and objective facts. Moreover, there are only very few service providers in the field that combine the necessary specialised knowledge and communication skills.
Alternative solution	Key players working in the field of offshore transmission technology have only limited communication skills, capacity and resources. Therefore, there have been few attempts to disseminate relevant technological findings and implications with stakeholders, decision makers and the wider public. The lack of communication has either not been seen as a problem, or not been addressed at all. There are only very few service providers in the field that combine the necessary specialised expert knowledge and communication skills to effectively do so. One of the few providers, the European Science Communication Institute (ESCI), for instance, supports national and international research initiatives in communicating effectively and leveraging their dissemination potential. Full-service communication agencies sometimes provide these services as well.
Unique Selling Point USP - Unique Value Proposition UVP	Based on experience in both the technical field of offshore grids and stakeholder communication, Stiftung Offshore-Windenergie (SOW) is uniquely positioned to fill that gap and offer effective communication services for similar technical research projects. The SOW Board of Trustees represents key stakeholders, e.g. policy-makers, TSOs, offshore wind developers and HVDC supply chain. Dedicated working groups inside SOW are dealing with the topic of offshore grid connection issues. Moreover, SOW is an active member at European trade associations, e.g. WindEurope.
Description	SOW can offer the full range of dissemination and communication services for offshore technology research, including e.g. • drafting and dissemination of communicative texts (adapted and designed for different audiences and formats),

	• preparation and set-up of communication formats (e.g. workshops, presentations, panel discussions, or technical and policy-oriented conferences), • visualisation of research results (for example, into striking graphics, tables and images), • management of citizen engagement process through events and advice, • awareness campaigns, • and management of stakeholder and decision maker relations.
"Market" – *Target market* (Customers)	SOW offers dedicated communication services especially for projects working on offshore_**Abbreviations** transmission grids and technologies, as well as any similar and related topics in the offshore wind energy sector, both in the EU and/or international context (Horizon2020, other European funding), as well as national research funding, global funding). Geographically, the market is not necessarily limited to any one region. The number of projects and research endeavours dealing with offshore technology issues with dissemination potential cannot currently be estimated. Similar projects SOW contributed to include Baltic InteGrid, South Baltic OFF.E.R. and SEANERGY 2020.
Early Adopters	Potential early adopters include other existing and future Horizon2020 projects – and especially, new Connecting Europe Facility (pilot) projects and/or studies in the field of offshore wind/offshore grids – with similar research areas and potentially the non-research sector. The first projects SOW will offer dissemination and communication services to will likely be follow-up projects to PROMOTioN.
"Market" - Competitors	There are a only a few other market participants that have developed special expertise in communication and dissemination of highly technical issues to a wider audience of stakeholders, decision makers and the general public on a European and national level. Many of these have more staff than SOW and special knowledge on the general technology topics and communication fields (for example the European Science Communication Institute). However, service providers (such as ESCI) do not have the internal stakeholder network (e.g. political decision makers and the industry/business and R&D community), research project experience and intrinsic involvement in the offshore wind industry - all of which SOW possesses.
Go to Market – Use model	SOW can support national and international research initiatives by communicating research results effectively and leveraging their dissemination potential through active stakeholder engagement via frequent newsletters, event announcements via email to subscribers as well as continuous update and maintainance of PROMOTioN's website as the main hub of communications. The website also functions as a data repository to store PROMOTioN delieverables and publications, following best practices under a Creative Commons License SOW will use its experience, knowledge and skills as well as its professional network which has been further developed during the PROMOTioN project to acquire further projects in the national, European and global context. Where necessary and appropriate, SOW will cooperate with other relevant industry and R&D stakeholders. After the PROMOTioN project, SOW will strive to boost and facilitate effective communication of the resulting deployment plan deliverable in order to achieve its implementation.
Go to Market – Background IPR	None
Go to Market – Foreground IPR	None

Go to Market	SOW can offer the full range of dissemination and communication services for offshore technology research, including e.g. • drafting and dissemination of communicative texts (adapted and designed for different audiences and formats),

	• preparation and set-up of communication formats (e.g. workshops, presentations, panel discussions, or technical and policy-oriented conferences), • visualisation of research results (for example, into striking graphics, tables and images), • management of citizen engagement process through events and advice, • awareness campaigns, • and management of stakeholder and decision maker relations.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**

DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner		
		A group of partners		
	A new research project (application to public funded research programmes)	A partner	Yes	
		A group of partners	Maybe	
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		

3.21.2 EXPLOITATION ROADMAP

Exploitation Roadmap

Actions	After the end of the project, SOW will disseminate the key findings and results to its wider stakeholder network and provide a summary of the services provided in PROMOTioN. This summary will present the variety of services that SOW has successfully delivered. In cooperation with the existing partner and stakeholder network, SOW will attempt to join the development of potential follow-up projects and sharpen the scope and content of future services that SOW can offer.
Roles	Discussion with partners may lead to new projects, the same goes for discussions with other stakeholders. In some cases, partners might serve as a subcontractor within the scope of a larger research project.
Milestones	a) dissemination of project results and services; 2020 b) acquisition of one or more new projects; 2020/2021 c) expanding services. 2021-2023 .
Impact in 3-year time	SOW could potentially hire two additional project managers to take care of the new projects. On the macro level, the further dissemination of PROMOTioN's project results may eventually increase acceptance of offshore wind energy as a whole among key stakeholders.
Financial Costs	One staff member would probably need 12 to 24 months to establish the necessary service portfolio and acquire a new project. Depending on the seniority of the staff member, costs will likely be in the range of 70,000 to 100,000 EUR.
Revenues	As a non-profit organisation, SOW does not generate profits and can only cover the costs claimed for project execution. Estimating revenues is currently impossible, as a fully new business plan would need to be established.
Other Sources of coverage	The staff member working on projects acquisition has needs to be covered from common sources of financing of SOW, either project funding or stakeholder grants.

3.21.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***3***	***1***	**3,0**		***6***	**18,0**
	Disagreement on ownership rules	*3*	*1*		Legal mediation of ownership disputes	*6*	
2	**Technological Risk Factors**	***4***	***3***	**12,0**		***5***	**60,0**
	better technology emerges	*3*	*1*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*5*	
	limited market (flow limitations)	*5*	*5*		Re-design of product to match new markets	*5*	
3	**Market Risk Factors**	***4***	***5***	**17,5**		***3***	**52,5**
	Nobody buys the product. Rejected by end-users.	*3*	*5*		Studies/ talks with potential customers on why service is rejected and alteration/ adaption of service quality	*4*	
	difficulty in market penetration/customer reception and acceptance of technology	*4*	*5*		Breaking down the overall service in smaller parts to adjust and offer more customized services	*2*	
5	**Financial/management Risk Factors**	***6***	***3***	**15,0**		***6***	**82,5**
	Weak exploitation: Inadequate business plan	*6*	*2*		revision of business plan and adaption to satisfy the financial side of things	*7*	
	Lack of endorsement from top management	*6*	*3*		Further assessment of benefits for the overall company and implementation of service in long-term strategic vision of top management	*4*	

Priority map of Exploitable result

Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

3.22 KER NO.22 - FEASIBILITY AND KNOWLEDGE ON AC-MESHED OFFSHORE GRIDS

KER Leading Partner: Siemens

3.22.1 CHARACTERIZATION OF THE RESULT

Feasibility and knowledge on ac-meshed offshore grids	
Problem	Different solutions for meshed offshore grids are being discussed and heavily researched. The actual drivers of such extensions are among others economical aspects and security of supply considerations. Up to now, extension of existing assets with new HVDC technology by using mature AC equipment was not yet demonstrated.
Alternative solution	Up to now, grid access of offshore wind farms was limited to single AC or HVDC connections (depending on step-out-range of wind farms).
Unique Selling Point USP - Unique Value Proposition UVP	Existing AC equipment and mature, cost-efficient technology (e.g. diode rectifiers) was shown to provide means for a meshed offshore grid with only little changes imposed on existing transmission assets. Siemens is therefore convinced that AC meshing may be a first step when considering an increased offshore meshing in the North Sea.
Description	The feasibility of an offshore AC-meshing based on different power-exporting technologies (e.g. AC subsea cables, VSC-HVDC transmission or diode rectifiers) has been demonstrated. In the process, expert knowledge has been established on how such topologies can be built and integrated even when mixing said technologies. It has been shown that little changes have to be made on existing transmission assets (by updating C&P software) when combining them with cost-efficient solutions as e.g. DRU or AC connections.
"Market" – Target market	All Transmission System Operators (TSOs) playing an active role in the export of renewable energy from offshore to onshore grids. Early adopters could be any TSO already having several HVDC links in the North Sea and requiring a higher degree of flexibility and security of supply while minimising additional expenses and/or interaction with existing systems.
"Market" - Competitors	One advantage of AC-meshed offshore grids is the increased range of potential manufacturers. Since the underlying equipment is well-established in onshore AC grids, this guarantees for a high degree of competitors which is likely to result in a further reduction of total costs.
Go to Market – Use model	The operational experience gained in the PROMOTioN project distinguishes Siemens Energy with an advanced knowledge when it comes providing timely solutions for the implementation of a meshed offshore grid.
Go to Market – IPR	Transmission equipment (such as DRU).
Go to Market – IPR	Know-how on integration and mixing of different technologies and operational experience (e.g. control changes, sequences, fault handling).
Go to Market	Estimated time-to-market ranges from “immediately” to 1-3 years time span, depening on technological choices.

3.23 KER NO.23 – STANDARDIZATION OF MODELLING AND TESTING OF HARMONICS

KER Leading Partner: Denmark’s Technical University (DTU)

3.23.1 CHARACTERIZATION OF THE RESULT

Standardization of modelling and test of harmonics	
Problem	Modelling and test of "harmonics" (here understood as frequencies different from the fundamental 50Hz or 60 Hz) emission and stability from wind turbines and wind power plants is currently decoupled in standards and best practices. Thus, the existing standard procedures for test and quantification of harmonic currents and voltages are not sufficient to characterize wind turbines and therefore cannot be used to assess harmonic emission and stability prior to building a wind power plant. Currently, harmonic models are supplied by some wind power plant developers enabling TSOs to simulate harmonic emission and interoperatility with other converters. However, there is no standardized way to validate those harmonic models based on standard tests. In order to have sufficient confidence in the harmonic models, a consistent standard approach for modelling, test and model validation is needed, not only for HVDC connected wind power plants but generally in increasingly converter dominated power systems.
Alternative solution	There is an ongoing effort from test institutes to propose more tests, e.g. of background harmonics without the device under test connected to the grid. Such tests can provide important information, but it is not considered sufficient to provide grid operator with necessary models and data.
Unique Selling Point USP - Unique Value Proposition UVP	DTU Wind Energy has been involved in IEC standardization on test and electrical modelling of wind turbines for more than 20 years. DTU owns and operates two test stations for large wind turbines in Denmark. The wind power industry (OEMs as well as wind power plant developers) provide black box models which need to be supplemented with open generic models. There is a need to study combined deterministic and probabilistic modelling of harmonics, to better understand the extrapolation from single wind turbine / converter tests to wind power plant and system integration level
Description	DTU Wind Energy is a university department, and therefore a primary and important result is the associated research and publication. But also the impact in society is important for DTU. In the case of harmonic modelling, the potential impact through standardization is very significant and important. Thus, standard ways to validate harmonic models is a cornerstone making it possible for power system operators to use vendor models in assessment of system stability and power quality. This "work share" is working today for fundamental frequency models, but not for harmonics.
"Market" – *Target market* (Customers)	Regarding "market", both the contributions to international research and the potential for research based consultancy should be considered. Besides the research and consultancy opportunities that this gives DTU, original equiemment manufacturers, offshore wind power developers and grid operators will profit from standardization of modelling and test of harmonics
Early Adopters	Early adopters are wind power plant developers and wind turbine manufacturers as well as grid operators, and also the solar PV and storage community.
"Market" - Competitors	DTU Wind Energy's competitors are universities and research institutes like NREL in USA, who is at the same time an important collaborator. Test institutes like LORC in Denmark, Franuhofer IWES in Germany are potential collaborators but also to some extent competitors.
Go to Market – Use model	The main way to generate an impact in society is through the implementation in standards. But there is also potential opportunities for impact through research based consultancy, especially in early stages where the methods are not used by commercial consultant companies.
Go to Market – IPR	Experience with measurement of harmonics, modelling in the frequency domain and combined deterministic / probabilistic modelling
Go to Market – IPR	Generic harmonic models, methods to test and validate harmonic models, and potentially also harmonic stability assessement with high shares of converter based generation
Go to Market	2-3 years

KER's Exploitation Form					Comments
(how the KER will be further exploited – Select only an option)					
Selected route		**Implementing actor**	**Yes**	**No**	
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		x	
		A group of partners		x	
	Contract research (new contracts signed by the research group with external clients)	A partner		x	
		A group of partners		x	
		A partner		x	

	A new research project (application to public funded research programmes)	A group of partners	x		The next step is to apply for R&D funding. The Danish Energy Development and Demonstration Program (EUDP) is most promising for this. It is the intension to apply together with partners from wind (and solar) industry, test institute and grid operation
	Implementation of a new university - course (Note that a training course is a service)	A partner		x	There is also potential to use findings in university education - both modelling and testing
		A group of partners		x	
		A new partnership		x	
INDIRECT USE	Transfer of ownership (IPR)	A partner		x	
		A group of partners		x	
	Licensing IPR	A partner		x	
		A group of partners		x	
	Development of a new legislation/standard	A partner		x	
		A group of partners		x	
	Spin- off	A partner		x	
		A group of partners		x	
		By assignment		x	
		By licensing		x	

3.23.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	The developed methodologies will be disseminated in research publications and standardization (IEC 61400-21). They results also found the basis for new R&D projects and for verification in laboratory and test facility
Roles	DTU Wind Energy will continue research in the area and use laboratory and down-scaled test facility to validate the reserarch. The research and developmnet will be done in collaboration with industry, test institutes and grid operators.
Milestones	2020: Simulation based results and specifications to tests 2021: PhD thesis including validation based on test results from collaboraiton partners and own facility if possible 2022: Establishment of ~1 MVA Controllable Grid Interface (CGI) with possibility to harmonics injection for test purpose

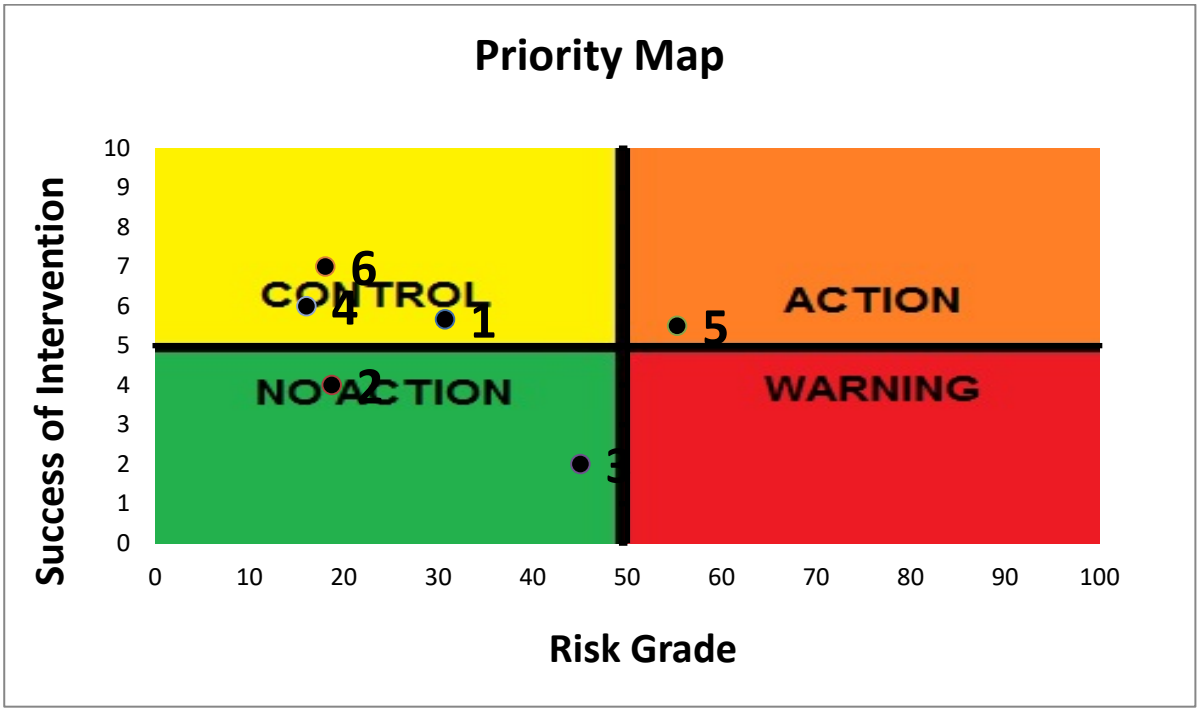
Impact in 3-years time	The work will strengthen DTU's position in international research and give new opportunities to acquire funding for more research in the area. It will also strengthen the quality of DTUs education of MSc and PhD candidates wiht sufficient insight to help industry and grid operators to implement the green transition in . The main impact in society is the contribution to ensure safe and reliable deployment of massive scale power converters in future low-emmission power systems. Therefore, the technology will create jobs for testing, but also found the necessary basis to enable the low-emission development.
Financial costs	The financial costs of new research and development projects in this area is expected to be 2-3 M€ over a 3 years period.
Revenues	DTU is a non-commercial government university without the mission to earn profits to the public owner. The costs for research, test and education should be covered by public funding. DTU may supplement the public funding using the results to offer consultancy, either as advisor or on al little longer horizon, even for full scale tests.
Other sources of coverage	An application has been submitted to Danish roadmap for national research infrastructure. If granted, this will cover 50% of the expenses for an advanced test faciliy which can amongst others be used for validation of harmonic modelling and test methods.

3.23.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***8***	***4***	**30,7**		***6***	**173,8**
	Disagreement on ownership rules	*8*	*7*		If necessary then change the consortium so that direct competitors are in same project(s)	*5*	
	Industrialization at risk: a partner declares bankruptcy.	*6*	*2*		Exchange the bankrupted partner with a competitor	*6*	
	Industrialization at risk: no manufacturer for the exploitable result.	*9*	*3*		Adjust technical requirements to match what is possible	*6*	
2	**Technological Risk Factors**	***7***	***3***	**18,7**		***4***	**74,7**
	Worthless result: better technology/methodology exists.	*9*	*3*		Work on improvement of methodology to make it competitive	*3*	
	Significant dependency on other technologies.	*7*	*3*		Assess existing market technologies and assess other opportunities	*3*	
	The life cycle of the new technology is too short.	*5*	*2*		Keep following RD&D and try to be on top	*6*	
3	**Market Risk Factors**	***9***	***5***	**45,0**		***2***	**90,0**
	Worthless result: performance lower than market needs.	*8*	*4*		Disseminate in education and wait for market to mature	*2*	
	Nobody buys the product. Too expensive.	*10*	*6*		Let commercial institutes go for it - collaborate where possible	*2*	
4	**IPR/legal Risk Factors**	***4***	***4***	**16,0**		***6***	**96,0**

	Legal problems: we are sued for patent infringement.	*4*	*4*		Reassess legal position to be prepared or to withdraw	*6*	
5	**Financial/management Risk Factors**	***9***	***7***	**55,3**		***6***	**303,9**
	Weak exploitation: Inadequate business plan	*8*	*6*		Develop better business plan - in collaboration with industry partners	*5*	
	No resources (human and/or financial) secured to make the next step toward exploitation	*9*	*7*		Try again - maybe other funding sources	*6*	
6	**Environmental/regulatory Risk Factors**	***3***	***6***	**18,0**		***7***	**126,0**
	Product/service does not comply with the standards.	*3*	*6*		Justify in research and keep working with and influencing standardization	*7*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The technological risks and market risks are low and not expected to hinder the process. This does not mean that there are not technological challenges, but the risk is low that applied research cannot overcome those challenges.

Actions are needed to establish the right partnerships of manufacturerers, offshore wind power developers, grid operators, test institutes and research institutes to ensure the specification of credible models and test methods. Inclusion of grid operators, certification bodies and regulators will help to ensure that environmental and regulatory barriers are considered.

The financial risks are the most critical: will it be possible to raise required funding for the research and testing needed to develop and validate sufficiently credible methods for modelling and testing. The work already done in PROMOTioN should be used as step stones towards funding of new projects.

3.24 **KER NO.24** – DEMONSTRATION OF CONTROL AND PROTECTION CONCEPTS FOR MULTI-TERMINAL HVDC GRIDS

KER Leading Partner: RWTH University

3.24.1 CHARACTERIZATION OF THE RESULT

Demonstration of Control and Protection Concepts for Multi-Terminal HVDC GRIDs	
Problem	• TSOs and manufacturers have very limited experience with the operation of MTDC (Multi-Terminal Direct Current) systems as there is only one multi-terminal HVDC grid in operation today based on VSC technology, which is located in China; • There is insufficient knowledge regarding the interaction of MTDC systems with the AC (alternating current) transmission system and the offshore WPPs (wind power plants) while these interactions should be already taken into account when MTDC systems are designed, not thereafter; • The control and protection concepts are typically developed using offline simulations, but need to be demonstrated before the system is manufactured; • Testing and validations of new control and protection concepts or approaches on real MTDC system are very costly and currently impracticable. A downscaled hardware setup (KER2) is affordable for TSOs and manufacturers and thereby serves the market by closing the gap for potential customers.
Alternative solution	• Offline simulation models (current practice at manufacturers and TSOs): Can be utilized to develop operational, control and protection concepts and to assess the impact of HVDC systems on AC systems. Simulation models usually differ from hardware implementations, i.e. the switching of power electronic components. Boundary conditions of the controls are different from a hardware system (e.g. signal delays, signal noise, synchronism of the controls); • Full-scale replicas representing the control of real projects in combination with real-time compatible models: Provide the most accurate alternative solution. A full-scale replica is costly, impracticable and oversized for research purposes. The use of the replicas for research might not be granted by the supplier. Full-scale replicas are currently not used from both academia and industry due to their high costs.
Unique Selling Point USP - Unique Value Proposition UVP	The MMC test bench allows real-time simulation using a Power hardware in-the-loop (PHIL) approach, such that on the one hand, control replica with manufacturer controls can be integrated and on the other hand, the converter's physical response is taken into account. The hardware is designed in a way that allows the investigation of a broad range of grid topologies and converter concepts, which are under discussion for future HVDC systems. In a first step, the test bench enables the demonstration of control and protection concepts from research in a way that allows a higher technology readiness level. In a second step, when the experience with the system is high enough the MMC test bench and knowledge can be offered as a service.
Description	The core of the test bench system are eight laboratory-scaled MMCs manufactured by OPAL-RT, which can be configured as half- and full-bridge converters. The scaled MMCs comprise 10 cells per arm, have a rated DC voltage of 400 V and a power rating of 6 kW each. The DC network is represented by cascaded Pi sections, which can be configured as symmetrical monopole and bipole. To investigate the interactions between HVDC grids, offshore WPPs and AC transmission systems, the MMCs are embedded in a real-time simulation of the surrounding AC systems by the usage of four-quadrant linear power amplifiers in a Power-Hardware-in-the-Loop (PHIL) setup.
"Market" – *Target market* (Customers)	Exploitation:

	• Research progress & PhD theses: Strengthening the competence of RWTH Aachen University in this field (real-time PHIL simulations for HVDC systems). Demonstration of developed concepts. • Offering services to TSOs and manufacturers. The focus lays on the European market with its three HVDC manufactures and relevant TSOs with planned HVDC systems (more than 10 TSOs until 2025), but it is not limited to it.
Early Adopters	Researchers and European TSOs with an interest in integration of MTDC systems.
"Market" - Competitors	The use of control and power hardware in the loop has been proposed and implemented before for the investigation of HVDC converters by other research institutions and universities, like Supergrid institute, SINTEF, Imperial college London and the university of Lille. These institutions do have an advantage as they have already gained experience with operating such systems. The MMC test-bench set-up in Aachen, however, allows a wider range of converter configurations and system topologies, which is crucial for investigations of future large HVDC systems and their interaction with the AC grids.
Go to Market – Use model	<u>Demonstration of technical readiness level of new control and protection concepts:</u> The MMC test bench is crucial to transfer the research results gained by offline simulation studies into a more realisting environment including hardware in the loop. This will allow universities to increase the credibility of their developed concepts. <u>Provision of a service to TSOs and manufacturers:</u> In a second step the competence gained in operating such hardware in the loop systems can be offered as a service for real-time and PHIL studies of proposed operational concepts. The TSOs and manufacturers can either aquire the services for the implementation of the proposed concepts on the test bench or also rent the test bench facilities and corresponding research associates to implement and test their proposed concepts together. Outlook: The MMC test bench can evolve to an international test centre for the analysis and conformance tests of new control concepts (MMC and other converters, such as WT converters) with future transmission and HVDC systems. <u>Solutions for the TSO:</u> • To de-risk the operation and control of MTDC systems, the MMC test bench provides a laboratory environment that allows the combination of real-time simulation with AC grids (i.e.AC transmission grids and offshore windfarms) and physical lab-scale MMCs. • MMC test bench is able to incorporate different control replica, i.e. control replicas of wind turbine converters and MMCs. • Test bench allows TSOs (and manufacturers) online system studies for affordable costs. <u>Improvement of research and acquisition of new researchs:</u> The MMC test bench offers a new level of detail in the research activities of the RWTH Aachen University. The research opportunities assosicated with this test bench will attract researches, enable the application for new research grants and projects as well as improve the reputation of the university in the research field. Moreover, the education and training of students with the system enhances their experise and increases their qualification for jobs in the power system and HVDC industry.
Go to Market Background – IPR	Previously existing expertise in HVDC control and protection strategies and AC grid modelling for dynamic simulations. RWTH owns this background. This was not listed as official IPR in the grant agreement, only in the work package description.
Go to Market Foreground – IPR	• Setup of the MMC test bench, experience gain in operating the system; • Agreements with the partners are clear until the end of the project;

	• After the project has ended, the test bench will be financed by a follow-up project with a third party (or it must be returned to the producer OPAL-RT according to the lease contract);
Go to Market - Which is the time to market?	The setup of the MMC test bench will be accomplished during the course of this project. Moreover, suitable models and controls for the test bench will be developed and implemented. Operating experience with the system will be gained by a series of test cases carried out as defined in D16.1. These test cases include four major topics: • Controllability and Interoperability • Fault Handling in Offshore Grids • Resonance Phenomena • AC Grid Support

3.24.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	1. Acquisition of a follow-up project to ensure a permanent financing of the MMC test bench 2. Increasing the knowledge at RWTH by including the test bench into research and teaching. 3. Dissemination of the test bench, e.g. by publishing papers or participation in relevant events for the HVDC industry 4. Enhancement of the customer number to create a position for additional research associates. 5. If required for future projects: Extension of the setup 6. Continuous monitoring of the exploitation
Roles *Roles of partners involved*	No roles for other partners after the project has ended
Milestones *List the milestones and monitoring parameters*	1. Acquisition of a follow-up project which includes the usage of the MMC test bench (by 30.09.2020); Main monitoring parameters: - Identify suitable project calls - Identify and contact interested project partners - Draft of a project plan - Discussion of the project plan with the interested partners - Adjustement of the project plan - Official application 2. Increasing the knowledge and expertise at RWTH (by 28.03.2021) - Develop a seminar dedicated to power hardware in the loop simulations - Use the MMC test bench for four bachelor and master as well as two PhD theses 3. Dissemination of the test bench (by October 2021) - Publication of 3 papers and articles by the end of the project - Publication of 3 papers in the first year after the project 4. Recruitment of employees (research associate) for follow-up projects - One by March 2020 - One by October 2020

Impact in 3-year-time	Investigations that can be carried out with the MMC test bench will contribute to a minimum of four PhD theses at RWTH university and additionally enable the RWTH to acquire new projects (e.g. for third-party funds) as well as to offer relevant research positions for future graduates. Several papers will be published on topics such as PHIL simulations, MTDC grids and grid-forming operation, further developing the reputation of RWTH in these research fields. Furthermore, acceptance in the industry (TSOs, manufacturers) for the new investigation methods is pursued and shall be achieved within 3-year-time after PROMOTioN has ended. Hereby, the provided possibility of testing HVDC control and protection concepts on a lab-scaled system will contribute to both, an increased security of supply in the future European transmission grid with numerous HVDC systems and lower operational costs due to the benefiting system reliability.
Financials **Costs**	Personnel for the operation and the saving of know-how, the lease & operating costs, project acquisition costs & dissemination costs (travel costs) RWTH can cover the costs during the gap between the end of the project and the next steps planned by its financial reserves. The management of the institute at which the MMC test bench is set-up has agreed to this. Without this consent the MMC test bench would not have been possible.
Revenues	Financial reserves within the RWTH are available to cover initial costs; Follow-up projects with the industry (TSOs & manufacturers) will cover future costs and generate revenues.
Other sources of coverage	-

3.24.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***8***	***4,5***	**36**		***6,5***	**234**
	Industrialization at risk: no manufacturer for the exploitable result.	*8*	*5*		Look for alternative manufacturers	*8*	
	Disagreement on ownership rules	*8*	*4*		Initiate consortium meeting to explain usage issues and redefine roadmap of exploitation and ownership rules	*5*	
2	**Technological Risk Factors**	***8***	***2***	**16,0**		***5***	**80,0**
	Worthless result: better technology/methodology exists.	*8*	*2*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*5*	
3	**Market Risk Factors**	***7,7***	***3,4***	**26,4**		***7,3***	**194,0**
	Exploitation disagreement: partners on the same market.	*8*	*8*		Discuss exploitation proposals and ensure that parallel exploitation is beneficial and in the interest of marketing the technology. additional market studies, customer surveys and assessment of product shortfalls	*9*	
	Exploitation disagreement: partners with divergent interests.	*8*	*2*		Discuss exploitation proposals and ensure that parallel exploitation is beneficial and in the interest of marketing the technology. additional market studies, customer surveys and assessment of product shortfalls	*9*	
	Worthless result: performance lower than market needs.	*9*	*4*		Improving performance	*8*	
	Nobody buys the product. Nobody needs it.	*10*	*1*		Dissemination of product performance possibilities	*6*	
	Nobody buys the product. Too expensive.	*7*	*5*		Alternative manufacturers, financing	*7*	
	Nobody buys the product. Rejected by end-users.	*8*	*2*		Very clear performance functions	*5*	

	Nobody buys the product. Standards to make it compulsory don't yet exist.	*4*	*2*		Give it a unique value		
4	**IPR/legal Risk Factors**	***9***	***2***	**18,0**		***8***	**144,0**
	Legal problems: proceeding against us.	*9*	*2*		Stricter control in in patent usage and aggressive pursuit of legal action	*8*	
5	**Financial/management Risk Factors**	***8,5***	***5,5***	**46,8**		***6***	**280,5**
	No resources (human and/or financial) secured to make the next step toward exploitation	*8*	*2*			*5*	
	Off time supply of financial means.	*9*	*9*		Look for another financial means	*7*	
6	**Environmental/regulatory Risk Factors**	***8***	***1***	**8,0**		***8***	**64,0**
	Not in compliance with regulations	*8*	*1*		Assessment of legal/regulatory requirements and alteration of product to comply	*8*	

Priority map of Exploitable result

Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Partnership, Market, IPR/legal, Financial/Management, Environmental risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Is defined a situation where it would be preferable to keep an eye on what is happening (Control) to be ready to act. Considering Partnership risk factors a potential intervention should be looking for alternative manufacturers and within the consortium meeting explain the usage issue and redefine the roadmap of exploitation and ownership rules. For the Market risks a solution should be discussing on exploitation proposals and try to improve performance.
Be aware on stricter control in patent usage and aggressive pursuit of legal action concerning IPR/legal risks. In case of Financial risk factors should be to evaluate another financial means. For environmental/regulatory risk factors a potential solution should be an assessment of legal/regulatory requirements and alteration of product to comply.

The Technological risks present a situation between Control and No action, where is a low risk grade with a medium probability of success of the planned remedy. A potential intervention could be a re-evaluation of technology and further optimisation to match/outperform new benchmark.

3.25 KER NO.25 – CONTROL HARDWARE IN THE LOOP TEST BENCH

KER Leading Partner: UPV

3.25.1 CHARACTERIZATION OF THE RESULT

Control Hardware in the Loop Test Bench	
Problem	Operation of DRU WPP is a growing technology that has been proved to be cheaper that the common converters based in IGBTs due to reduction in the equipment needed and space in the off-shore platform. However, experience regarding the operation of DRU WPP as well as their interaction with the HVDC links is limited. This leads to opposition from manufacturers and TSOs for investments in the new technology. This uncertainty paralyses the introduction of this improvement in the market. And also limiting and slowing the development of grid forming WPP associated with DRUs.
Alternative solution	So far mainly offline simulations have been used to assess the impact of HVDC systems. However, different models were used for different purposes (e.g. RMS and EMT models in separate environments for different purposes). Example of this studies are the two articles refered: L. Yu, R. Li, L. Xu and G. P. Adam, "Analysis and Control of Offshore Wind Farms Connected with Diode Rectifier based HVDC System," in *IEEE Transactions on Power Delivery*. doi:10.1109/TPWRD.2019.2960405 **http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8935398&isnumber=4359248** S. Añó-Villalba, S. Bernal-Perez, J. Martinez-Turegano and R. Blasco-Gimenez, "Impedance-based Stability Analysis for HVDC Diode-Rectifier Connected Off-shore Wind Farms," *IECON 2019 - 45th Annual Conference of the IEEE Industrial Electronics Society*, Lisbon, Portugal, 2019, pp. 2389-2394. doi: 10.1109/IECON.2019.8927634 **http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8927634&isnumber=8926608** In the meanwhile, other converter and HVDC related technologies can be extensively field-tested. For example, all the testbench available in Supergrid installations. **https://www.supergrid-institute.com/en/** For the complex interaction between DRU WPP, AC and DC systems, the simulations become more complex and the integration of the manufacturer controls and physical demonstrations become more challenging. No testbench is available including DRU.
Unique Selling Point USP - Unique Value Proposition UVP	The Control on the loop testbench proposed will be the best to include DRU WPP. It will increase the reliability of the system, compared with the off-line simulations because it will allow real-time simulation and control hardware in-the-loop simulations (CHIL). The protection's physical response is taken into account by the integration of commercial devices for grid monitoring and protections.

Description	To solve the lack of a reliable testbench able to perform all test regarding DRU-WPP and able to include external commercial devices as protections and machine controls, the WPP is embedded in a real-time simulator manufactured by OPAL-RT. WP park control is configured out of the system, and real protections are connected in a HVDC scaled link. This integrated system will let to investigate the interactions between HVCD grids, offshore wind power plants and AC transmission systems.
"Market" – *Target market* (Customers)	Having research as the main organisation's objective, CHIL will attack private research funding, allowing further academic and collaborative research. So, the targets for the KER are: Research progress & PhD thesis/ Strengthening the competence of UPV in this field/ Service to TSOs and manufacturers
Early Adopters	European TSO**s** and manufacturers with an interest in integration of DRU systems and interoperability of protections in **HVDC** grids. • RED Eléctrica (SPAIN) managing important links nearby (Inelfe between Spain-France) • Iberdrola: Present in Spain and Southamerica. • Schneider: Involve in early development of this solution, interested in protections and adaptations of its products to future requirements.
"Market" – Competitors	SINTEF / University of Lille/ Imperial College London To de-risk the operation and control of DRU WPP, the control on the loop test bench provides a laboratory environment that allows the combination of real-time simulation with JVDC and AC grids and physical protections. Moreover, the system can incorporate different control replicas, i.e. control replicas of wind turbine converters. This allows TSOs and manufacturers to test control and protection concepts and analyse the interaction between different converters.
Go to Market – Use model	Provision of a service to TSOs and manufacturers: • Testing of developed control and protection concepts; • competence in Real-time; • CHIL simulations. The testbench can support manufacturers and **TSO**s for the analysis and conformance tests of new control concepts (DRU and other converters, such as WT converters) with future transmission and HVDC systems.
Go to Market – IPR	Previously existing expertise in WPP-DRU control and HVDC grid modelling for dynamic simulations.
Go to Market – IPR	Set-up of the CHIL testbench, experience gain in operating the system.
Go to Market	Official presentation of the test bench will be performed 31st March 2020, before the end of the projects. All functionalities will be available, the ones need to perform and obtain results compromised. In this moment, the solution will be marked. Further functionalities and options required by future customers will be cover by future contracts.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel oduct/service (offered to the target markets)	One partner		x

		A group of partners		x
	Contract research (new contracts signed by the search group with external clients)	A partner	x	
		A group of partners		x
	A new research project (application to public funded search programmes)	A partner		x
		A group of partners		x
	Implementation of a new university - course (Note that training course is a service)	A partner		x
		A group of partners		x
		A new partnership		x
INDIRECT USE	Transfer of ownership (IPR)	A partner		x
		A group of partners		x
	Licensing IPR	A partner		x
		A group of partners		x
	Development of a new legislation/standard	A partner		x
		A group of partners		x
	Spin- off	A partner		x
		A group of partners		x
		By assignment		x
		By licensing		x
	Other (please describe)			x

3.25.2 EXPLOITATION ROADMAP

<table>
<tr><th colspan="2">Exploitation Roadmap</th></tr>
<tr><td>Actions</td><td>After official presentation of the test bench, 31st March, PROMOTioN of the facility will start among potential customers.
During next 6 months the main actions are focus on promoting and improving the tool:
2 more demonstration test are scheduled, concentrating the presence of potential customers.
Creation of PROMOTioN material: web site and booklet.
Recruit of new staff to operate and improve the testbench.</td></tr>
<tr><td>Roles</td><td>No other partner than UPV involved.</td></tr>
<tr><td>Milestones</td><td><table>
<tr><th></th><th>Monitoring Parameter</th><th>Milestone (KPI)</th></tr>
<tr><td>2020-2021</td><td>PHd Thesis based on CHIL performance</td><td>1</td></tr>
<tr><td>2021-2022</td><td>Research contracts and services</td><td>2</td></tr>
<tr><td>2022-2023</td><td>Customer consolidation, new research. PHd thesys based on new results.</td><td>1</td></tr>
</table></td></tr>
<tr><td>Impact in 3-years time</td><td>PHD Thesis based on results/ Alliance with companies.</td></tr>
<tr><td>Financial Costs</td><td>Most important investment is already done at the end of the project. Maintenance and skilled manpower will be needed.

Cost of manpower/year: 15.577,66 euros.</td></tr>
<tr><td>Revenues</td><td>The service will be ready at the end of the project.
The future ways to cover cost are: Contract with companies / Student and Research Grants.</td></tr>
<tr><td>Other Sources of coverage</td><td>The CHIL lab will be included in the research facilities of our institute to attract technology and investment companies. The success in these first services will encourage future possible relationships.</td></tr>
</table>

3.25.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***8***	***1***	**8,0**		***9***	**72,0**
	Disagreement on ownership rules	*8*	*1*		Specified in Grant Agreement, Article 31.3 Access rights for other beneficiaries, for exploiting their own results. Ask for mediation.	*9*	
2	**Technological Risk Factors**	***8***	***2***	**16,0**		***5***	**80,0**
	Worthless result: better technology/methodology exists.	*8*	*2*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*5*	
3	**Market Risk Factors**	***8***	***3***	**27,1**		***8***	**226,2**
	Exploitation disagreement: partners on the same market.	*8*	*8*		Discuss exploitation proposals and ensure that parallel exploitation is beneficial and in the interest of marketing the technology. additional market studies, customer surveys and assessment of product shortfalls	*9*	
	Exploitation disagreement: partners with divergent interests.	*8*	*2*		discuss exploitation proposals and ensure that parallel exploitation is beneficial and in the interest of marketing the technology. additional market studies, customer surveys and assessment of product shortfalls	*9*	
	Worthless result: performance lower than market needs.	*9*	*4*		Improving performance	*8*	
	Nobody buys the product. Nobody needs it.	*7*	*1*		Dissemination of product performance possibilities	*6*	
	Nobody buys the product. Too expensive.	*7*	*3*		Alternative manufacturers, financing	*9*	
	Nobody buys the product. Rejected by end-users.	*8*	*2*		Very clear performance functions	*9*	
	Difficulty in market penetration/customer reception and acceptance of technology	*10*					
4	**IPR/legal Risk Factors**	***9***	***2***	**18,0**		***8***	**144,0**

	Legal problems: proceeding against us.	*9*	*2*		Stricter control in patent usage and aggressive pursuit of legal action	*8*	
5	**Financial/management Risk Factors**	***9***	***6***			***6***	
	No resources (human and/or financial) secured to make the next step toward exploitation	*8*	*2*	**46,8**	Look for new resources	*5*	**280,5**
	Off time supply of financial means.	*9*	*9*		Look for another financial means	*7*	
6	**Environmental/regulatory Risk Factors**	***8***	***1***	**8,0**		***8***	**64,0**
	not in compliance with regulations	*8*	*1*		assessment of legal/regulatory requirements and alteration of product to comply	*8*	

Priority map of Exploitable result

Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Technological risk factors present a situation between Control and No action, where is a low risk grade with a medium probability of success of the planned remedy. It should be re-evaluated the technology and further optimised to match/outperform new benchmark.

The Partnership, Market, IPR/legal, Financial/Management, Environmental risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act.
Considering the Partnership risk factors should be found an agreement on ownership rules as specified in Grant Agreement. In terms of Market risks should be discussed the exploitation proposals and ensured that parallel exploitation is beneficial and in the interest of marketing the technology. additional market studies, customer surveys and assessment of product shortfalls. To avoid legal problems, should be applied stricter control in patent usage and aggressive pursuit of legal action. Concerning the financial/management risk factors, a solution would be to look for new resources. In order to be compliant with regulations of Environmental risk should be assessed legal/regulatory requirements and alteration of the product to comply.

3.26 **KER NO.26** – DEVELOPMENT OF SCOPF FOR MESHED AC/DC TRANSMISSION SYSTEMS

KER Leading Partner: FGH

3.26.1 CHARACTERIZATION OF THE RESULT

Development of Scopr for Meshed AC/DC Transmission Systems	
Problem	Transmission System Operators (TSO) must perform power flow calculations in various processes, e.g.: • grid planning; • operational planning • system management Besides calculating a standard optimal power flow (OPF) in these processes, the TSO has to consider the behaviour of the system in contingency situations as well. These are performed with an outage simulation, which simulates the system in case of outages on different parts of the network. For these possibilities, an **OPF** has to be determined with preventive or curative measures. This so-called Security Constrained OPF (SCOPF) has to take into account meshed HVDC systems in the future as well, embedded into the AC-transmission system and connecting asynchronous transmission systems. Without this SCOPF, TSOs will not be able to determine the impact of contingencies of HVDC connections within their transmission system and therefore can neither design nor plan their system or determine necessary operational remedial measures accordingly.
Alternative solution	Calculations with meshed HVDC systems are not yet required for TOSs and therefore no other solutions are available. Our own software can already consider point-to-point (P2P) HVDC connections in the calculations, but no meshed HVDC-systems. HVDC P2P connections are considered as separate injections in software from competitors and not as detailed HVDC connections. As the potential customers cannot solve the problem with available software tools, they contacted us to integrate these new functions.
Unique Selling Point USP - Unique Value Proposition UVP	First one to offer the desired function/solution on the market in already used software product covering all other variables in AC networks for optimization, which minimises the learning curve for customers.
Description	Our software product "INTEGRAL" is a grid planning tool with a graphical user interface. Different calculation/simulation components are able to perform power flow or short circuit studies, market simulations, SCOPFs and more. The new function "SCOPF of meshed AC/DC Transmission Systems" is going to be integrated into the already available optimisation framework. Users can then plan their transmission systems in both AC and DC and are able to calculate the behaviour of the system when outages occur (utilization of lines and transformers, resulting node voltages). The calculation of these outage situations is done by an approximation, which makes the software framework also ready for additional time-sensitive calculations in customer-tailored products.

"Market" – *Target market* (Customers)	The target market are German-speaking TSOs (and DSOs) (B2B). The departments: • Asset management - grid planning; • System operations (when using a tailored product). All four German TSOs are potential customers with each employee in grid planning needing a license. Additionally, Regional Security Coordinators (RSC) could use the software for system operations, with one in Germany using a predecessor version at the moment.
Early Adopters	The four German TSOs are the early adopters of the software solution. They are included in quarterly update calls about the progress of the software and have therefore already shown interest in the product. As they all already use our product, it is highly likely that all their licenses will be updated to the new function.
"Market" – Competitors	To our knowledge, no competitors with this product AND specific function on the market available yet. Other grid planning tools from competitors (e.g. PowerFactory) could be upgraded in the future and also introduce this specific function, as the basic knowledge is publicly available. The differences will be the usability and especially calculation time of the software solution.
Go to Market – Use model	The software can be bought in different software license packages to allow usage. The here mentioned SCOPF could be either integrated into an existing package (the optimisation framework) or marketed as a new option. Customers could buy/upgrade the corresponding software license. The cooperation and service contracts have to be renewed every ear to obtain a license for the new year.
Go to Market – IPR	The Consortium Agreement already states that FGH has their own developed software (IP) and no beneficiary will gain access to the source code. The software cannot be used by other beneficiaries for the exploitation of the product results.
Go to Market – IPR	We have all the rights to exploit the findings/Foreground as we are the only one developing the software. The created programming code developed by FGH within the PROMOTioN project belongs to us and cannot be exploited by other beneficiaries.
Go to Market	• Final development of the algorithm and integration into software; • Development of GUI for the new function; • Internal testing and benchmarking of finished software; • Delivery and sales of finished product via subsidiary / promoting new function (End of 2020). The occurring costs are about 1.5 MM = 30,000 € (see below in “Financial Costs”)

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	X	
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner		
		A group of partners		
	A new research project (application to public funded research programmes)	A partner		
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

3.26.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	• Finalization of algorithm in source code (09/2020); • Adding new functionalities in GUI of software product (10/2020); • Testing, benchmarking and bug fixing of software (10/2020); • Market and explain new software function to potential customers (10/2020); • Deliver software and licenses to new customers (11/2020). • Further optimization and support of software after in use at the customer (after 11/2020)
Roles	Subsidiary of FGH is integrating the algorithm into the main source code. Afterwards a developer of that subsidiary is integrating the new function into the GUI of the software. Testing and benchmarking will be executed from several employees at FGH in parallel. Presentation of new functions will occur during web conference with customers, FGH subsidiary will do that. Same goes for delivering software and licenses to customers.
Milestones	• MS1: software functions implemented (10/2020); • MS2: Benchmarking tests of new function successfully finished (10/2020); • MS3: Benchmarking of Release Candidate successful (whole software product) (end of 10/2020); • MS4: Delivery of final software (11/2020).
Impact in 3-year time	Delivery in late 2020, with no impact on additional jobs. New projects could lead to additional revenue but data is not yet available in detail.
Financial Costs	Additional costs: • Software developer (GUI) • Software developer (Testing) • Software developer (Presentation and Delivering) → 1.5 MM = 30,000 €
Revenues	Revenues depend on licensing model used for new software function. As the price is not determined yet, revenue cannot be calculated.
Other Sources of coverage	The financial costs mentioned before for the developers are taken from current revenue of the software product.

3.26.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***5***	***0***	**0,0**		***5***	**0,0**
	Disagreement on ownership rules	*5*	*0*		Legal mediation of ownership disputes and patent review	*5*	
	Industrialization at risk: a partner declares bankruptcy.	*5*	*0*		initiate consortium meeting to explain usage issues and redefine roadmap of exploitation	*5*	
	Industrialization at risk: a business partner leaves the market.	*5*	*0*		maintain communication with exiting expert and organise hand-over and training	*5*	
	Industrialization at risk: no manufacturer for the exploitable result.	*5*	*0*		find another manufacturer for exploitable result	*5*	
	Disagreement on further investments: some partners may leave.	*5*	*0*		Legal mediation of ownership disputes with partners and investment procurement	*5*	
2	**Technological Risk Factors**	***8***	***3***	**24,0**		***9***	**204,0**
	better technology emerges	*8*	*4*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*8*	
	Significant dependency on other technologies.	*8*	*2*		Use of alternative software solution	*9*	
3	**Market Risk Factors**	***8***	***2***	**13,9**		***7***	**101,9**
	Nobody buys the product. Nobody needs it.	*10*	*2*		reuse of implemented software base for other projects	*5*	
	Worthless result: performance lower than market needs.	*7*	*1*		improve of software base to achieve better performance and accuracy	*9*	
	Nobody buys the product. Too expensive.	*8*	*2*		Assessment of pricing model and widening of customer base by using software in other products	*8*	

4	**IPR/legal Risk Factors**	***6***	***6***	**36,0**		***4***	**126,0**
	Know- how risks: it is easy to counterfeit the product	*6*	*3*		strict control of license usage and technological documentation	*5*	
	Know- how risks: a counterfeit cannot be proved.	*6*	*9*		legal actions	*2*	
5	**Financial/management Risk Factors**	***6***	***1***	**6,0**		***5***	**30,0**
	Know- how risks: there are leaks of confidential information.	*6*	*1*		legal actions	*5*	
6	**Environmental/regulatory Risk Factors**	***0***	***0***	**0,0**		***0***	**0,0**
	not in compliance with regulations	*0*	*0*		assessment of legal/regulatory requirements and alteration of product to comply	*0*	

Priority map of Exploitable result

Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Partnership and the Financial/Management risk factors present a situation between Control and No action, where is a low risk grade with a medium probability of success of the planned remedy. Considering the Partnership risk factors a possible type of intervention is a legal mediation of ownership disputes with partners and investment procurement. A possible intervention for Financial/Management risks are legal actions.

The IPR/legal risk factors present a low-risk grade and a low probability of success for the remedy, it is a situation does not call for immediate action (no action).

The Technological and Market risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act. In case of Technological risk factors should be re-evaluated the technology and further optimisation to match/outperform new benchmark. The Market risk factors should improve a software base to achieve better performance and accuracy.

3.27 **KER NO.27** - STANDARDIZATION OF WT CONVERTER IMPEDANCE MODELS VALIDATION

KER Leading Partner: Ørsted

3.27.1 CHARACTERIZATION OF THE RESULT

Standardization of WT Converter Impedance Models Validation	
Problem	Standardization of WT converter impedance models validation is missing. The industry could benefit from an industrially agreed way of performing validation of converter impedance models for WTs (and other converter-based components too)
Alternative solution	Models are as of today delivered, when required, based on OEM validation. This is done following the OEM experience and judgement, and not following a widely agreed procedure. Though the results can be effective, transparency is missing on validation procedures and technical requirements cannot be written in a fully unambiguous way. This can lead to misunderstanding, delays, added risks, etc.
Unique Selling Point USP - Unique Value Proposition UVP	Standardization of validation procedures for impedance models for WTs would enable: - Sharper technical requirements and thereby more effective allocation of responsibilities - Faster model validation and thereby earlier de-risking of projects - Reduction of possibility of misunderstandings leading to poor model development resulting in delays, risks, etc.
Description	The results achieved in PROMOTioN are a step further towards standardization of impedance model validation, that should be continued in standardization bodies (e.g. IEC). This standardization may go hand in hand with that of harmonic models and should consider the following: - Available validation levels and related accuracy/challenges - Necessary level of validation at different stages of a project, relying on results from WP16 - Expansion to other models which can be used for the same or similar purposes - Expansion to system-level validation
"Market" – Target market (Customers)	TSOs, developers, OEMs, testing facilities, standardization organizations Note that this is an effort that needs contributions from the whole industry for it to happen
Early Adopters	OEMs must be involved as it is their equipment that undergoes validation TSOs and developers must be engaged to move the industry in the right direction by adopting standards as they become available
"Market" - Competitors	No real competitors, but there might be reluctance to change the status quo unless consensus is reached on the importance of this models
Go to Market – Use model	The standardization effort should be led by standardization bodies. Ideally, IEC would be the best place to do this, although an intermediate step could be for example through Cigré. Orsted is already involved in activities in this field in both IEC and Cigré.
Go to Market – IPR	NA
Go to Market – IPR	*NA*
Go to Market	*Standardization requires at laest 3 years, so a likely timing is 5 years*

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		X
		A group of partners		X
	Contract research (new contracts signed by the research group with external clients)	A partner		X
		A group of partners		X
	A new research project (application to public funded research programmes)	A partner		X
		A group of partners		X
	Implementation of a new university - course (Note that a training course is a service)	A partner		X
		A group of partners		X
		A new partnership		X
INDIRECT USE	Transfer of ownership (IPR)	A partner		X
		A group of partners		X
	Licensing IPR	A partner		X
		A group of partners		X
	Development of a new legislation/standard	A partner		X
		A group of partners	X	
	Spin- off	A partner		X
		A group of partners		X
		By assignment		X
		By licensing		X
	Other (please describe)			X

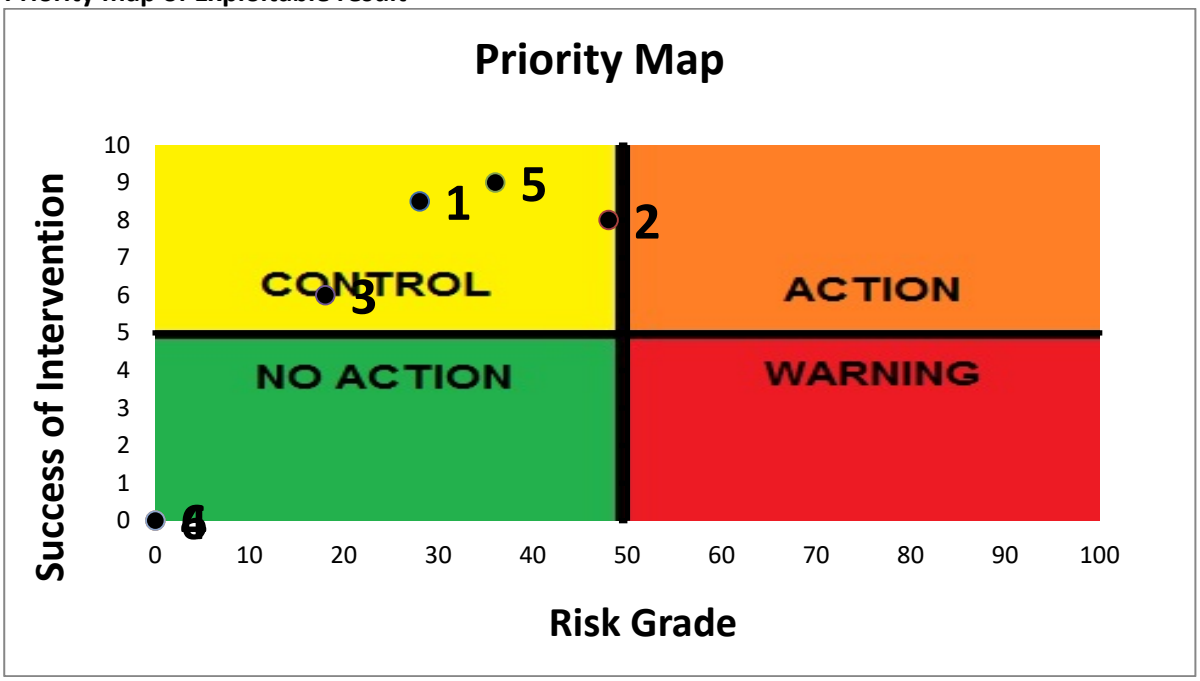
3.27.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	*Evaluate possibility to create dedicated working groups in relevant bodies (IEC as first option, Cigré as fallback)*
Roles	*TSOs and developers: setting function of standard* *Manufacturers: main players in standard definition* *Universities/Research/Consultancies: provide expertise and independent eye*
Milestones	*As per usual standard development: draft, consultantion, etc.*
Impact in 3-year time	*Lower project risk and thereby lower cost*
Financial costs	*Only man-power from the different parties is needed*
Revenues	*As per other standards being developed continuously*
Other sources of coverage	*NA*

3.27.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***8***	***4***	**28,0**		***9***	**238,0**
	Lack of agreement between partners on standardisation	*7*	*4*		Experienced independent standard chairman to find best compromise. Use of revisions to improve agreement in successive publications	*9*	
	Lack of sufficient industrial representation to compile meaningful standard	*9*	*3*		Develop standard as spin-off of current activities	*8*	
2	**Technological Risk Factors**	***8***	***6***	**48,0**		***8***	**384,0**
	Standard ill-developed or out-paced by technology development and needs revision	*8*	*6*		Arrange standard in revisions and agree on update plan	*8*	
3	**Market Risk Factors**	***9***	***2***	**18,0**		***6***	**108,0**
	Nobody makes use of the standard - not needed	*9*	*1*		Consider full revision of standard	*5*	
	Nobody makes use of the standard - not considered useful	*9*	*3*		Partners with experience to provide more transparency on justifications of the need for standard	*7*	
5	**Financial/management Risk Factors**	***6***	***6***	**36,0**		***9***	**324,0**
	Excessive delay in publication	*6*	*6*		Publish in versions with clear plan for revisions	*9*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Partnership and Technological risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act. The Partnership risks should maintain a communication with exiting expert and organised a hand over and training. Considering the Technological risk factors the technology should be re-evaluated and further optimised to match/outperform new benchmark.

Considering Market, IPR/legal, Financial/Management and Environmental risk factors have been registered a low-risk grade and a low probability of success for the remedy, this situation does not call for immediate action.

3.28 KER NO.28 - CONSULTANCY SERVICES

Leading Partner: Carbon Trust

3.28.1 CHARACTERIZATION OF THE RESULT

Consultancy Services	
Problem	• Our clients are often time poor and want to have access to concise information or experts to help them understand how the offshore wind sector may develop in Europe and to keep abreast of the latest technological and policy developments. Without this information, OWF developers may not be fully aware of all risks associated with OSW development and therefore may not have in place proper mitigation measures. • Our clients also want to ensure that their R&D spend is focused on delivering relevant innovation projects and not duplicating existing work. The offshore wind and energy sector would function without these services being provided by the Carbon Trust (and others) but clients may make less cost optimal decisions on investments and R&D spend in the absence of up to date knowledge. It is difficult to quantify the impact a less coordinated approach would have, but in the UK (and elsewhere), it is estimated that the benefits of the Carbon Trust's Offshore Wind Accelerator (OWA) - a coordinated, joint industry approach to offshore wind cost reduction research & development - has resulted in a 15% reduction in the levelised cost of offshore wind over the last 10 years[8].
Alternative solution	In the UK offshore wind farms are connected radially to the shore via offshore wind generator-built, offshore transmission owned (OFTO) assets. Our clients (offshore wind developers) could continue to construct offshore wind transmissions assets and the onshore network owners could continue to operate and invest in the onshore grid to accommodate these radial connections. This solution could continue, but the UK has ambitious offshore wind deployment forecasts and is increasingly aware of the potential integration challenges of increased offshore wind on the onshore network.
Unique Selling Point USP - Unique Value Proposition UVP	Carbon Trust's involvement in PROMOTioN has given us an in-depth insight and understanding of the costs and benefits of meshed HVDC networks and, in particular of the policy implications of developing a meshed offshore grid. We have excellent connections with OWF developers, network companies, government and the supply chain. The Carbon Trust brand is well respected, and we have significant convening power to bring together different organisations and deliver joint industry projects. We can apply the learnings from PROMOTioN to other relevant projects – this could enable our clients to make better decisions about how to operate or invest in new assets (wind farms, onshore and offshore networks or innovation projects related to these). We are the only UK-headquartered energy consultancy in the PROMOTioN consortium.

[8] Link: https://www.carbontrust.com/news-and-events/news/10-years-of-the-offshore-wind-accelerator-and-beyond

Description	The Carbon Trust is a consultancy. We deliver a range of projects for clients in the energy and climate change sectors. As part of this we also manage two large offshore wind research and development programmes – the Offshore Wind Accelerator (OWA) and the Floating Offshore Wind Joint Industry Project (FLW JIP). The Carbon Trust's role is to chair the programme, work with programme partners to agree the scope of the research projects to be delivered, and to commission and manage delivery of those projects. The PROMOTioN project will not result in a new service being delivered, but the Carbon Trust's involvement in PROMOTioN has given us a better understanding of the value of HVDC meshed grids, how they could be delivered, and the remaining research gaps and priorities. This knowledge can inform our approach to other offshore wind consultancy projects, and the projects commissioned by the Offshore Wind Accelorator and Floating Wind (FLW) Joint Industry Projects (JIP), while avoiding duplication of work.
"Market" – *Target market* (Customers)	UK Network Owners and offshore wind farms developers (particularly those involved in the OWA and FLW JIP).
Early Adopters	We have already had conversations with those involved in the technical work packages (particularly WP3, black start) to ensure that new research projects we commission under the OWA build on this latest knowledge and don't duplicate work. The partners in OWA are offshore wind developers working in the European market.
"Market" - Competitors	Our competitors are other energy and engineering consultancies working in Europe, particularly the UK. In the offshore wind sector, the Carbon Trust has significant experience in delivering joint industry projects and innovation projects. Our work in offshore wind is increasingly international – across Europe, Asia and North America. We have excellent connections with OWF developers, network companies, government and the supply chain. The Carbon Trust brand is well respected, and we have significant convening power to bring together different organisations. Other consultancies working in offshore wind will have different strengths – perhaps more engineering/technical focused or with more experience in certain countries.
Go to Market – Use model	The Carbon Trust is a consultancy. Therefore, we work with clients to develop and deliver projects, and we bid for work publicly tendered. We manage the delivery of projects under the OWA and FLW JIP - developers involved in these programmes contribute to a joint funding pot which is used to fund research and demonstration projects. Carbon Trust works with the developers to identify preferred research projects, which the Carbon Trust will then commission and manage. Our business model won't change as a result of PROMOTioN – we will use our existing links with industry (OWA and FLW JIP) to disseminate the PROMOTioN findings. When bidding for other projects we will mention our experience on the PROMOTioN project, and (where relevant) use the learnings from PROMOTioN to tailor our response to the proposal. Our goal is to ensure that we leverage the knowledge gained from PROMOTioN to deliver projects which better meet the client's need.
Go to Market – Background IPR	None stated in the Consortium Agreement
Go to Market – Foreground IPR	No Carbon-Trust specific IPR generated. We will make use of published PROMOTioN deliverables.
Go to Market	Immediate.

KER's Exploitation Form
(how the KER will be further exploited – Select only an option)

Selected route		Implementing actor	Yes	No
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	Yes	
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner	Yes	
		A group of partners	Maybe	
	A new research project (application to public funded research programmes)	A partner		
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

3.28.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	During last 3-6 months of project: Completion of WP12 (Deliverables 12.3, 12.4 and 12.5) will ensure the Carbon Trust is up-to-date with the deliverables and recommendations from each work package. Dissemination of results within wider Carbon Trust team. In first 6 months after PROMOTioN: Publicly available results and conclusions are likely to be shared with our partners in the offshore wind Joint Industry Projects we run (the Offshore Wind Accelerator (OWA) and Floating Wind JIP). These discussions may lead to the development of concepts for future projects. We will also be aware of publically tendered projects related to hybrid assets through our business development links. We will consider bidding for projects on these topics (likely as a consortia) leveraging the information gained through the PROMOTioN project.
Roles	Carbon Trust - Information Dissemination. Joint Industry Project partners & Carbon Trust - Identification of possible follow on projects.
Milestones	By June 2020: Presentation of results and conclusions internally. By Sept 2020: Presentation of results with industry partners.
Impact In 3-Year Time	The objective of the floating wind joint industry programmes is to reduce the total system cost of offshore wind and improve safety. Any projects carried out which build on the findings from PROMOTioN will have similar overarching objectives.
Financial Costs	Internal dissemination costs are minimal (time only). Any follow-on project costs are yet to be determined. These costs are likely to be classed (initially) as business development and will be met by the Carbon Trust.
Revenues	Carbon Trust is a consultancy. We receive funding from project partners to manage our joint industry projects and identify sources of finance to run larger projects within these programmes. When we bid for work, this is usually on a fixed cost or day rate basis.
Other Sources of Coverage	Any revenue required to deliver projects will be covered by client funding and/or public funding.

3.28.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***5***	***4***	**19,6**		***8***	**163,0**
	Disagreement on further investments: some partners may leave.	*7*	*5*		Carbon Trust has successfully run joint industry projects for several years, delivering several largescale projects in the offshore wind sector. We have well defined mechanisms to allow willing parties to fund projects without requiring the approval of all joint industry parties. This lowers the risk of a funding partner pulling out of a project.	*8*	
	Industrialization at risk: a partner declares bankruptcy.	*5*	*3*		We undertake financial due diligence checks on any party we provide funding too. The project funders are typically large, well established developers whose risk of bankruptcy is considered to be low.	*8*	
	Disagreement on ownership rules.	*4*	*3*		All projects we enter into clearly state the ownership of foreground and background IP and the rights of other parties to licence this IP.	*9*	
3	Market Risk Factors	*8*	*5*	40,0		*5*	200,0
	Exploitation disagreement: partners on the same market.	*8*	*5*		Exploitation options will be discussed with potential funding partners. We could run several smaller projects, if there isn't funding for a single larger project.	*5*	
	Exploitation disagreement: partners with divergent interests.	*8*	*5*		As above	*5*	
5	**Financial/management Risk Factors**	***9***	***5***	**45,0**		***5***	**225,0**

	No resources (human and/or financial) secured to make the next step toward exploitation	*9*	*5*		Any project which builds on the findings of PROMOTioN will be costed and funded at the outset. There are limited resources to fund and manage projects, so the bigger risk is that a PROMOTioN-related project is not selected, in favour of other project ideas.	*5*	
6	**Environmental/regulatory Risk Factors**	***4***	***1***	**4,0**		***9***	**36,0**
	Research is socially or ethically unacceptable.	*4*	*1*		It is unlikely that a socially or ethically unacceptable project would be suggested. However, if it were, there are several layers of scrutiny that each project passes through before starting.	*9*	

Priority map of Exploitable result

Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Market and Financial/Management risk factors present a situation between Control and No action, where is a low risk grade with a medium probability of success of the planned remedy. A possible type of intervention is to look for new training models and new targets.

The Partnership and environmental risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act.

3.29 **KER NO.29** - CONSULTANCY SERVICES ON HVDC AND OFFSHORE WIND INFRASTRUCTURE DEVELOPMENT

KER Leading Partner: Tractebel Impact and Engineering

3.29.1 CHARACTERIZATION OF THE RESULT

KER Tractebel Impact & Tractebel Engineering	
Problem	Tractebel/Engie Impact: - Capability to offer Consulting Services and Engineering Services in the offshore wind and power transmission industries - Capability to serve the internal ENGIE Group needs on the off-shore energy generation and transmission to the shore project development in the frame of the massive decarbonisation of energy sources and usages - Enlarge ENGIE ecosystem of services and products (i.e. Fabricom part of ENGIE Services Benelux already design and assemble off shore platforms for the wind power industry)
Alternative solution	Wind offshore connections to the shore are today based on point to point. Also the design of the electrical connection are customized to each project. A global systemic approach to the integration of massive of wind power in the European system with a focus on the offshore infrastructure was missing.
Unique Selling Point USP - Unique Value Proposition UVP	Tractebel/Engie Impact includes strong power system & energy market teams and related competences. The latter are used to offer strategic and foresight view on the evolution of a key energy markets such as competitive advantages of renewable energy versus natural gas. Positioning of wind and green gas in a utility portfolio, understanding the impact of a decentralised energy sources on the development of large scale infrastructure such as offshore wind are strategic questions for an energy producer. In that frame the transmission to shore was considered as one of the barriers to their massive penetration. The capability to master the design and quantify a large offshore HVDC meshed transmission infrastructure but also to assess the technological barriers and position in a consistent deployment roadmap the offshore generation and transmission infrastructure are very important and considered as a must have capability.
Description	Tractebel/Engie Impact contributed to: - the specification in the WP1 of the project of the HVDC meshed transmission system especially towards its integration with the existing HVDC infrastructure with the aim to understand the systemic impact of such an infrastructure - the capability to model HVDC meshed transmission in WP2 by developing the models in its tool (smartflow suite) with the aim of integrating new functionalities in its software tools - the estimation of the overal estimated cost by the development of a credible HVDC meshed infrastructure in WP12 which required to identify the promising wind resource locations in the North Sea, then develop the evolutive topology check some operational security requirements then derive the estimated cost by a bill of quantity performed by other Partners of WP12. This work strengthened Tractebel capabilities in large infrastructure planning. **As a result, all the key steps of the infrastructure development have been covered.**

"Market" – *Target market* (Customers)	Market targets are clearly B2T (TSO, Authorities in Europe, State owner utilities outside Europe) and B2B (private utilities and wind farm development companies). It is noted that other parts of the world are also targeting massive large scale REN infrastructure development for which the solutions developed in the frame of PROMOTION could be applicable for delivery of consulting services. The Middle East or Latin America transmission projects are also B2B target for Tractebel/Engie Impact.
Early Adopters	It is anticipated that the early adopters will be located in Europe (UK, West part of Europe). Middle East countries such Saudi Arabia (Gulf region) are also potential early adopters due to the ambitious solar large scale power plant capacity targets.
"Market" - Competitors	Competitors are 'technical' consulting companies especially in Europe. Some are stronger on the technical side, other on the economic or regulatory side.
Go to Market – Use model	The business model is the provision of consulting services often on the competitive basis (by opposition to negotiated contracts)
Go to Market – IPR	Software suite SMARTFLOW (existing product grade simulation software)
Go to Market – IPR	Part of the foreground is already integrated in the proprietary software suite (SMARTFLOW). Proof of Concept requiring significant developments will be integrated after management approval at the end of the project.
Go to Market	Some consulting assignments are already ongoing where large scale REN need to be transferred to on shore or to large consumption center on shore through HVDC technologies .

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	x	
		A group of partners		x
	Contract research (new contracts signed by the research group with external clients)	A partner	x	
		A group of partners		x
	A new research project (application to public funded research programmes)	A partner		x
		A group of partners		x
	Implementation of a new university - course (Note that a training course is a service)	A partner		x
		A group of partners		x
		A new partnership		x
INDIRECT USE	Transfer of ownership (IPR)	A partner		x
		A group of partners		x
	Licensing IPR	A partner	x	
		A group of partners		x
	Development of a new legislation/standard	A partner		x
		A group of partners		x
	Spin- off	A partner		x
		A group of partners		x
		By assignment		x
		By licensing		x
	Other (please describe)			

3.29.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	- Integrate in our software platforms the POC used in the frame of WP1/WP2 and WP12 project - Update the ENGIE Group strategy and ENGIE business units (BU) with the new perspectives and opportunities offered by the PROMOTION project results. These are the (BU Renewable Europe dealing with off shore wind but also BU Hydrogen that develop bulk H2 production projects and where HVDC technologies could play a significant role) - Include the PROMOTION foreground in our consulting offerings (consulting services already ongoing involving massive renewable projects and HVDC transmission) Useful background information: Two years after the beginning of PROMOTION, Tractebel acquired a German company Overdick (https://overdick-offshore.com/what-we-do/offshore-wind/) to strenghen the offshore activities of Tractebel (BU of the ENGIE Group). These capabilities should be linked with the ENGIE Fabricom capability to design/assemble offshore platform (https://www.engie-fabricom.com/en/renewable-energy/offshore-wind-energy/) for which the electrical system are designed in close coordination with electrical teams of Tractebel. In parallel ENGIE and EDP signed a strategic partnership that includes the joint development of large scale offshore windfarm (https://www.engie.com/en/activities/renewable-energies/wind-energy). The monitoring, the understanding and therefore the capability to advise on the transmission technologies is therefore critical for 900 MW+ projects.
Roles	Consulting service (Thrid Parties), Technical adviser (inside the Engie Group),
Milestones	Update offering and Commercial services: - immediate Before mid 2021: - integration of the POC results in the SMARTFLOW suite Before end 2021: - interaction with the ENGIE Group off shore wind BU interactions
Impact in 3-years time	Tractebel&Impact: Tractebel & Engie Impact are engineering and technical consulting company. The recent creation of Impact (2019 - therefore after the beginning of the PROMOTION project) is mainly oriented towards the decarbonisation of the B2B segment. The HVDC and offshore wind energy remain also an important piece of knowlegde in a company offering a diversified portfolio of decarbonisation technological options at global level (wind, solar, green H2, green/biogas for ENGIE). It is therefore important to be able to position correctly HVDC transmission and off-shore wind in this portfolio. Although the full impact is not easy to assess, a rough estimation is that 50% of the transmission projects will include HVDC technologies. Since some years a signifuicant part of the T&D engineering teams activity has been dedicated to the windfarm connection. It is anticipated that with the HVDC, the systemic dimension will become more important and activity is anticipated to increase with job creations. Jobs: Most power system engineers hired in the Brussels offices of ENGIE Impact have a knowlegde of HVDC. Investment mobilised: The expected CAPEX invested should remain limited to the industrial implementation in our software code of the POC developed in the frame of PROMOTION. It is anticipated that it represent between 6 ad 12 man.month as no equipment is acquired directly by Engie Impact. Turnover: It is anticipated that the generated turnover for the commercial services be of the

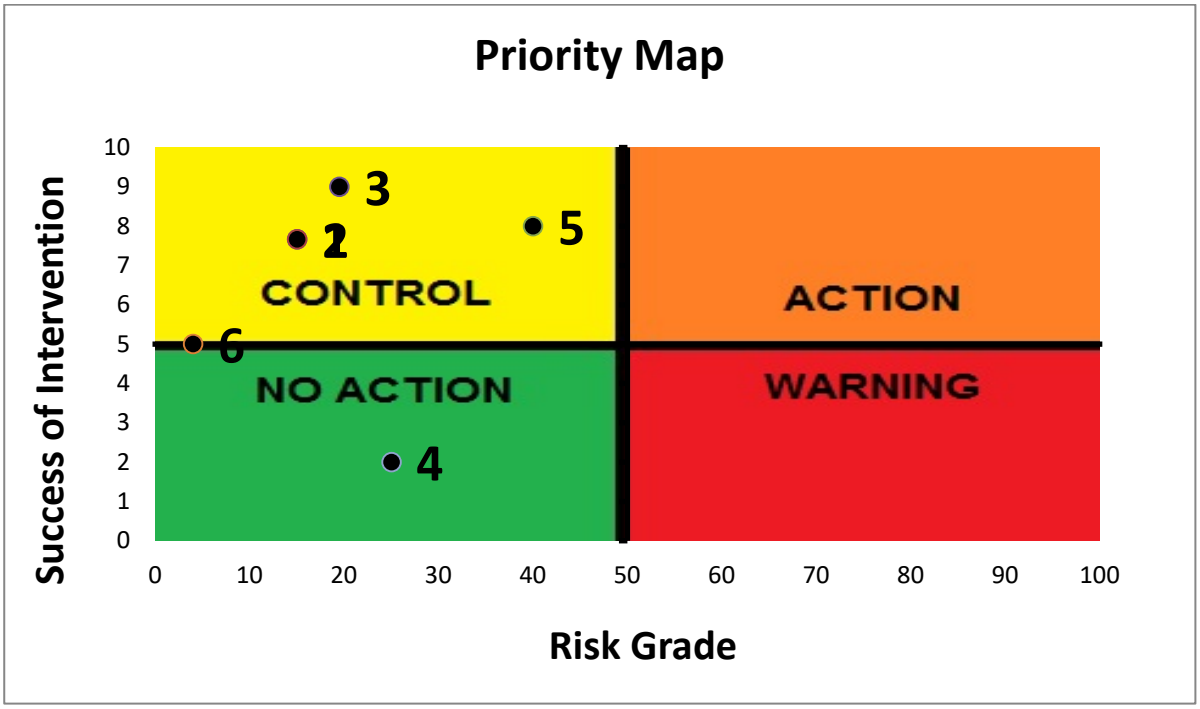
	magnitude of at least 2M€/year in the coming 3 years then 5 M€/year for Impact only (T&D engineering turnover for Tractebel and subsidiaries such as Overdick not included)
Financial costs	Financials Costs: mainly engineering and consulting cost Cost estimation to implement planned activities (1 year, 3 years): commercial costs Provide information on the costs/investments needed to bridge the end of the project to the next steps planned (you may invest in a patent, in the realisation of a prototype, etc.): none as services are proposed on commercial basis.
Revenues	consulting fees Services are offered either on lump sum or on cost+ basis. Estimation of risk and mitigation plans are carefully analysed at the offering stage to ensure the projected revenues are achieved.
other sources of coverage	*N/A*

3.29.3 RISK MATRIX

Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
Partnership Risk Factors	***5***	***3***			***8***	
Disagreement on ownership rules	*5*	*5*		Legal mediation of downership disputes and patent review	*5*	
Industrialization at risk: a partner declares bankruptcy.	*2*	*2*	**15,0**	initiate consortium meeting toexplain usage issues and redefine roadmap of exploitation	*9*	**115,0**
Industrialization at risk: a partner declares bankruptcy.	*8*	*2*		maintain communication with exiting expert and organise hand-over and training	*9*	
Technological Risk Factors	***3***	***5***			***8***	
better technology emerges	*1*	*5*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*9*	
limited market (flow limitations)	*5*	*5*	**15,0**	redesign of valve configuration to enhance range of device	*5*	**115,0**
valves aim to replace existing mechanical counterparts				correctly assess existing market technologies and assess performance and ability to penetrate market through replacement in exisiting applications	*9*	

Market Risk Factors	***7***	***3***			***9***	
Exploitation disagreement	*5*	*1*	**19,5**	discuss exploitation proposals and ensure that parappel exploitation is beneficial and in the interest of marketing the trechnology	*9*	**175,5**
difficulty in market penetration/customer reception and acceptance of technology	*8*	*5*		additional market studies, customer surveys and assessment of product shortfalls	*9*	
IPR/legal Risk Factors	***5***	***5***			***2***	
competitors replicate technology	*5*	*5*	**25,0**	stricter control in in patent usage and aggressive pursuit of legal action	*2*	**50,0**
Financial/management Risk Factors	***8***	***5***			***8***	
weak exploitation of the material	*8*	*5*	**40,0**	revision of exploitation plan and market research and relaunch of product	*8*	**320,0**
Environmental/regulatory Risk Factors	***2***	***2***			***5***	
not in compliance with regulations	*2*	*2*	**4,0**	assessment of legal/regulatory requirements and alteration of product to comply	*5*	**20,0**

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

3.30 **KER NO.30** - RECOMMENDATION ON MARKET DESIGN TO REMOVE ENTRY BARRIERS FOR OFFSHORE WIND IN THE BALANCING MARKET

KER Leading Partner: Florence School of Regulation (FSR – EUI)

3.30.1 CHARACTERIZATION OF THE RESULT

Recommendation on market design to remove entry barriers for offshore wind in the balancing market	
Problem	System operators are required to balance the system in real-time to ensure operational security by keeping the frequency within the prescribed limits. Today, with the advent and increase in penetration of intermittent renewable resources, the need for ensuring robust and well-functioning balancing markets is more challenging than before. - As balance responsible parties, a mal-functioning balancing market could drive up the cost of imbalanced intermittent generators who are exposed to high imbalance prices - There is also an active discussion on integrating non-dispatchable generation technologies as balancing service providers (BSPs). It is often claimed that a high entry barrier for intermittent renewable resources existed due to the balancing market design being more suited towards dispatchable generation technologies.
Alternative solution	Find ways within this to integrate intermittent renewables within the current market design without changing it. Completely ignore intermittent resources as balance responsible party (BRP) and balancing service providers BSP for Balancing
Unique Selling Point USP - Unique Value Proposition UVP	The recommendations are based on a comprehensive qualitative analysis of current regulations, their impact on offshore wind farms (as BSP and BRP) and identification of range of possible solutions. The study bridges the gap between academia and practice while developing an unique analytical framework. Furthermore, the benefits from the recommendation provided go beyond just Offshore wind to other RES technologies and DER.
Description	This research provides recommendations on implmenting a balancing market design that will eliminate market barries for offshore wind farms as BSPs and BRPs. The study developed and used an unique analytical framework that bridges the gap between academia and practice to assess the current balancing mechanisms from the perspective of offshore wind participation both as a balance-responsible party (BRP) and as a balancing service provider (BSP). We also investigate whether the interests of offshore wind are aligned with the interest of the system as a whole. Therefore, we provide a third perspective to this analysis where we assess the same issues at a system level. We also consider what is stated regarding these different points in the Electricity Balancing Guideline (EB GL) which was adopted in late 2017. The EB GL is one of the eight adopted European network codes and guidelines for electricity which are grounded in the Third Energy Package. Finally recommendations are provided based on this assessment for better integration of offshore wind. The key recommendations made were on imbalance settlement rules, imbalance settlement period, product and service definitions, use of scarcity pricing, need for well functioning intraday market and integrating balancing markets.

"Market" – *Target market* (Customers)	Policy makers, regulators, system operators, and offshore wind developers in the EU
Early Adopters	The recommendations can be presented to ACER, DG-ENER, NSEF, Florence Forum, NRAs and policy makers. The results have already been presented several times as part of the PROMOTioN dissemination efforts where several of the identified stakeholders were in attendance (e.g: NSEF Support Group 2 meetings). The research has also been published as a report, the link to which has been sent to FSR's mailing list consisting of experts and people from the identified groups.
"Market" - Competitors	Research insitutes that are working on similar market desging issues. These organisation may have different experties in terms of the type of analysis applied (such as quantitative models) used to develop their solutions.
Go to Market – Use model	Publish the result findings and present it to relevant stakeholders for consideration
Go to Market – IPR	The entire research was developed by FSR-EUI using in-house expertise.
Go to Market – IPR	Findings have been published as part of the PROMOTioN deliverable D7.4
Go to Market	The work is complete and already published as deliverable D7.4 and presented at several stakeholder events. During various phases of the research we have received feedback from internal and external stakeholders. Internally from PROMOTioN partners, and externally from stakeholders that attended the PROMOTioN Dissemenation activities. A third level of feedback from the FSR internal research team itself which consists of several experts on this topic.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		X
		A group of partners		X
	Contract research (new contracts signed by the research group with external clients)	A partner		X
		A group of partners		X
	A new research project (application to public funded research programmes)	A partner	X	
		A group of partners	X	
	Implementation of a new university - course (Note that a training course is a service)	A partner		X
		A group of partners		X
		A new partnership		X
INDIRECT USE	Transfer of ownership (IPR)	A partner		X
		A group of partners		X
	Licensing IPR	A partner		X
		A group of partners		X
	Development of a new legislation/standard	A partner	X	
		A group of partners	X	
	Spin- off	A partner		X
		A group of partners		X
		By assignment		X
		By licensing		X
	Other (please describe)			X

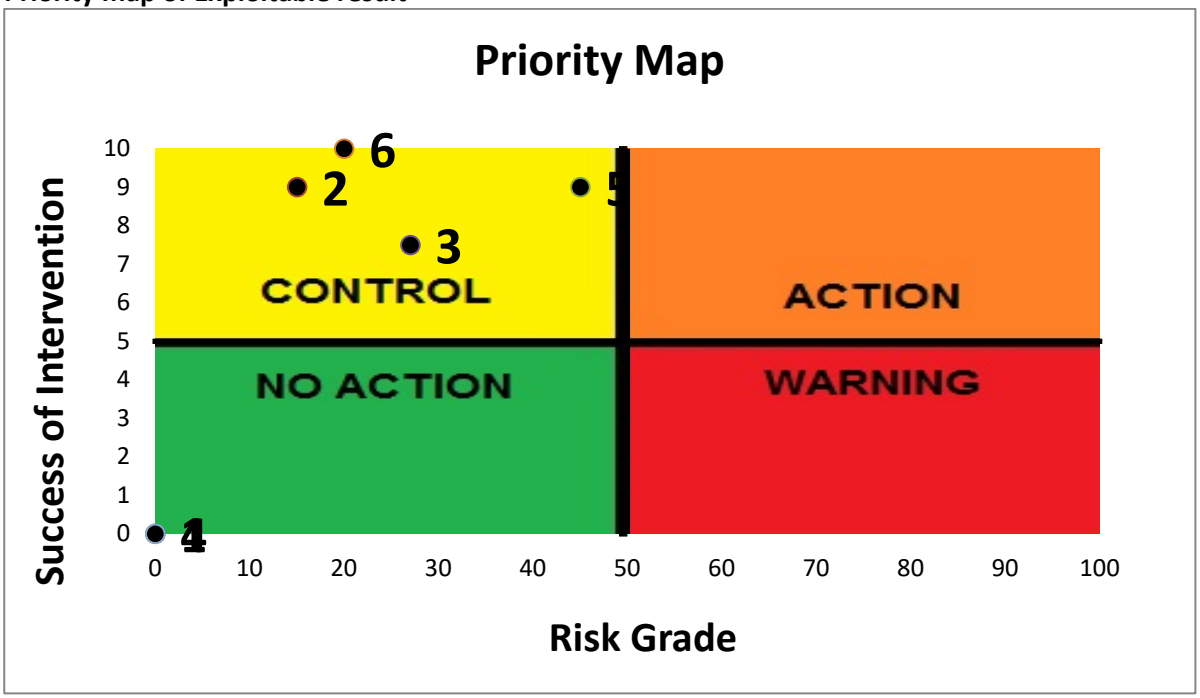
3.30.2 EXPLOITATION ROADMAP

Exploitation roadmap	
Actions	1) Continue to work closely with various stakeholders such as regulators and policy makers on this topic and others. FSR is a well known with the various stakeholders already as a platform of excellence for independent research, eduction and policy dialogue. Therefore many stakeholders already follow our work and its relevance to their domain. 2) Communicate the results from PROMOTioN to interested stakeholders at various platforms. The dedicated FSR media team works on getting all our latest work to the right stakeholders. In addition, all work is published open access as reports/policy briefs/working papers. The dissemination efforts within the PROMOTioN project has also allowed us to present our research and recommendation at various stakeholder events, conferences and dedicated workshops.
Roles	None. FSR has arrive at our results from a position of utmost neutrality and independence. Promoting the results through any industry stakeholder may not be the best strategy, but through other universities could be possible.
Milestones	FSR will monitor the progress using internal processes. The internal process broadly can be described as follows 1) During the research from the conceptualisation phase itself present work at internal FSR Research meeting (consisting of several experts research that understand these topic). 2) internalise the feedback and make necessary course corrections 3) This process can be repeated depending on feedback etc and a different level of development of the work 4) Completion of primary draft and review by all involved co-authors to reach a consensus version 4) Review of the draft internally by FSR researchers 5) After final green light draft made available to primary externals for their feedback. Timeline milestones will depend on gnatt chart and time available for completing the project and are structured accordingly to ensure delivery of on-time high quality research.
Impact in 3-years time	We expect our results to aid in the further development of a european common market, a more economically efficiently fuctioning power system with robust regulations and market design. The work must contribute towards enabling renewables, innvovation as well as sustainability. examples could be: 1) Any update to the TEN-E regulation 2) Any update to the network codes from the offshore grid perspective. 3) In development or update of relevant (surrounding the north sea) EU member state regulation and policy. 4) Maybe useful for ACER
Financial costs	The costs of the current research are covered by H2020. Any future costs would be borne by agencies that would commission future research on this topic to FSR.
Revenues	N/A
other sources of coverage	N/A

3.30.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
2	**Technological Risk Factors**	***5***	***3***	**15,0**		***9***	**135,0**
	Worthless result: better technology/methodology exists.	*5*	*3*		Ensure the policy recommendations are robust in the short medium and long term considering possible impact of disruptive innovation. Thus making sure that the relevant value proposition would remain	*9*	
3	**Market Risk Factors**	***5***	***6***	**27,0**		***8***	**202,5**
	Exploitation disagreement: partners on the same market.	*5*	*7*		Instead of competing collaborate with the partners to combine forces and come up with a better solutions. Develop a thinking of being quality driven rather than just revenue driven	*8*	
	difficulty in market penetration/customer reception and acceptance of technology	*4*	*5*		Identify the reasonable concerns of stakeholders and then find ways to incorporate solutions to mitigate these concerns	*7*	
5	**Financial/management Risk Factors**	***9***	***5***	**45,0**		***9***	**405,0**
	No resources (human and/or financial) secured to make the next step toward exploitation	*9*	*5*		Try to be part of consortium on reseach projects with interest on this topic to secure adequate resource	*9*	
6	**Environmental/regulatory Risk Factors**	***10***	***2***	**20,0**		***10***	**200,0**
	Influence of laws and regulations.	*10*	*2*		Make sure all latest policy and regulation changes are considered while making the recommendations	*10*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

3.31 **KER NO.31** - INCREASED COMPETETIVENESS OF EUROPEAN ELECTRIC COMPONENTS IN DISTRIBUTION AND TRANSMISSION NETWORKS

KER Leading Partner: T&D Europe

3.31.1 CHARACTERIZATION OF THE RESULT

Increaded Competetiveness of European Electric Components in Distribution and Transmission Networks	
Problem	T&D Europe is the Association of EU National Vendors Associations of transmission and distribution of electrical components. T&D Europe aims to increase the competitive advantage of our companies and consequently of all EU, with a number of instruments, facilitating knowledge sharing, R&D technology transfer, marketing strategies, deployment plans. PROMOTioN aims to produce a EU deployment plan based on fundamental pillars such as interoperability and Deployment Plan, technology innovation and it could be the solution for moving on a "common floor".
Alternative solution	So far companies' proposals of new solutions are not based on a common floor of strategy and interoperability. For this reason companies design solutions taking in consideration protocols and standards actually available at EU level. Moreover, companies in some situations collaborate from a technical point of view, in accordance with the antitrust rules.
Unique Selling Point USP - Unique Value Proposition UVP	As an Association, T&D Europe focus is to support the competitiveness of its members and the cooperation among them in the frame of antitrust rules. The deployment plan of PROMOTioN project is the most valuable product from T&D Europe point of view, and will intend to be a lighthouse for internal policy decisions and coordination on MOG, HVDC and DC current. This will impact on the competitiveness of EU manifacturers with the development of internal market (EU).
Description	Roadmap and vision about the future of MOG, HVDC, DC current that will support internal decisions and relations with European Commission, from all points of view: technical, political, economics. This will support the growth of the EU market.
"Market" – *Target market* (Customers)	The EU market for vendors is B2B. The market in which the products of vendors can compete is mainly composed by operators of North Europe, but also South of Europe could benefit by a strong North market, thanks to the next "e-highways" paradigm. Both companies and Europe will profit from better coordination: the first thanks to a growthing number of sold products and maintenance activities, the second thank to a strongest market that can compete with the rest of the world (in particular US and China).
Early Adopters	Energy policies and standardization Working Groups of T&D Europe and companies that are already members of PROMOTioN consortium, ABB, Siemens, GE, etc
"Market" - Competitors	EU Nations that are not members of T&D Europe could propose alternative models of deployment. The main competitors at the end are outside Europe, and could impose their integrated model. The risk is the lost of EU competitiveness. In order to prevent this, we will adopt focused comunication strategies, coordinating these actions with EU Commissions, DG Energy in particular.
Go to Market – Use model	On the basis of the Deployment Plan and standardization guidelines, in agreement with antitrust rules - T&D Europe is guaranter for them - the Association will propose a model to all T&D Europe members. The model will be based on communication iniziatives, webinar, events, social media interactions and official pubblications (white papers) that will support vendors (and

	consortium of vendors) with the proposal of complete solutions to member states and operators.
Go to Market – Background IPR	T&D Europe has to observe very strictly and regulated rules about confidentiality. T&D Europe is guaranter for antitrust among members, mainly related to prices and technologies IPR. In the case of PROMOTiON outcomes, what is of interest of T&D Europe is the Deployment Plan and the Standardization Guidelines, for these IPR issues are not relevant. Vendors are also members of the PROMOTiON consortium with their technologies and know-how, but this is out of the scope of T&D Europe objectives, their R&D results coming from R&D activities in PROMOTiON will be managed indipendently by these vendors, not involving T&D Europe. Vendors KERs, including IPR issues are managed in an independent way, have no relations with T&D Europe KER in PROMOTiON.
Go to Market – Foreground IPR	IPR of the model of application of Deployment Plan and Sdandardization Guidelines is not an issue for foreground partners or players.
Go to Market	T&D Europe will create a model of knowledge sharing, including one or more internal dissemination activities. We estimate for this phase 18 months from the end of the project.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		
		A group of partners	X	
	Contract research (new contracts signed by the research group with external clients)	A partner		
		A group of partners	X	
	A new research project (application to public funded research programmes)	A partner		
		A group of partners	X	
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners	X	
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

3.31.2 EXPLOITATION ROADMAP

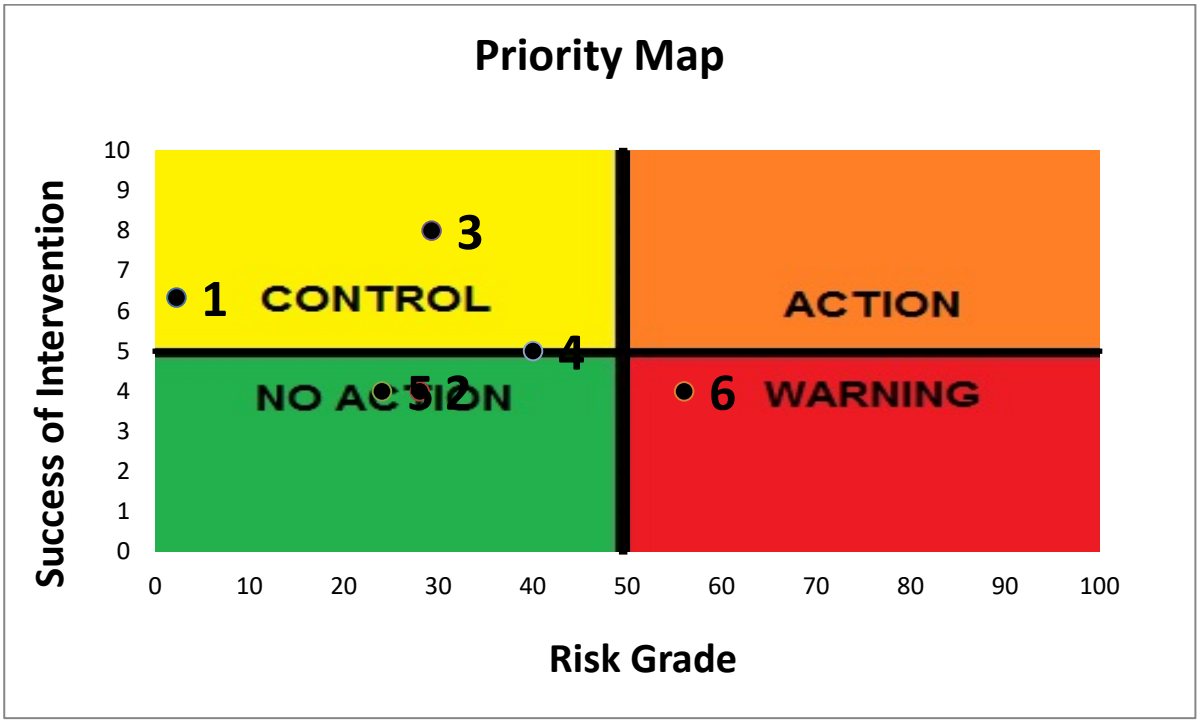
Exploitation Roadmap	
Actions	After the end of the project but also during the last months, T&D Europe board will be invited to organize dissemination activities. One of the activities is a webinar for the dissemination of results to all internal members (National Associations and EU vendors). Speaker will be choosen from the T&D Europe board and companies members of PROMOTioN consortium. Information will be delivered on digital channels as well. Second action, T&D Europe will address member companies to discuss about a interoperabilty model and adapt where possibile their business models to PROMOTioN Dissemination Plan, accordingly with antitrust rules.
Roles	T&D Europe: coordination, guaranter for antitrust rules; Member companies: eletrical components design and vendors
Milestones	1 Month after the end: webinar with T&D Europe members and digital dissemination 3 Months after the end: discussion of a interoperability model 6 Months after the end: guidelines for business models aligned with Disseminasion Plan 12 Months after the end: monitoring 18 Months after the end: monitoring
Impact in 3-years time	The aim is to improve the competitiveness of industries and then of EU.
Financial costs	Meetings and dissemination (1PM): E.14.000 Monitoring (2PMs): E.28.000 Models for interoperability and business (3PMs): E.42.000 Total (18 Months): E.84.000
Revenues	No direct economic revenues for T&D Europe (revenues are for member companies of T&D Europe)
other sources of coverage	Budget from member companies. Funded pojects with pubblic or private money.

3.31.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***1***	***2***	**2,2**		***6***	**14,1**
	Disagreement on ownership rules	*2*	*3*		Legal mediation of (d)ownership disputes and patent review	*7*	
	Industrialization at risk: a partner declares bankruptcy.	*1*	*1*		initiate consortium meeting to explain usage issues and redefine roadmap of exploitation	*8*	
	Industrialization at risk: an business partner leaves the market.	*1*	*1*		maintain communication with exiting expert and organise hand-over and training	*4*	
2	**Technological Risk Factors**	***6***	***5***	**28,0**		***4***	**112,0**
	better technology emerges	*7*	*5*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*2*	
	limited market (flow limitations)	*7*	*6*		redesign of valve configuration to enhance range of device	*4*	
	Result aiming at replacing existing and well entrenched technologies	*4*	*3*		correctly assess existing market technologies and assess performance and ability to penetrate market through replacement in exisiting applications	*6*	

3	**Market Risk Factors**	***7***	***5***	**29,3**		***8***	**234,0**
	Exploitation disagreement	*5*	*2*		discuss exploitation proposals and ensure that parappel exploitation is beneficial and in the interest of marketing the trechnology	*8*	
	difficulty in market penetration/customer reception and acceptance of technology	*8*	*7*		additional market studies, customer surveys and assessment of product shortfalls	*8*	
4	**IPR/legal Risk Factors**	***5***	***8***	**40,0**		***5***	**200,0**
	competitors replicate technology	*5*	*8*		stricter control in in patent usage and aggressive pursuit of legal action	*5*	
5	**Financial/management Risk Factors**	***6***	***4***	**24,0**		***4***	**96,0**
	weak exploitation of the material	*6*	*4*		revision of exploitation plan and market research and relaunch of product	*4*	
6	**Environmental/regulatory Risk Factors**	***8***	***7***	**56,0**		***4***	**224,0**
	not in compliance with regulations	*8*	*7*		assessment of legal/regulatory requirements and alteration of product to comply	*4*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

3.32 **KER NO.32** - DISTRIBUTED CONTROL OF GRID FORMING WIND TURBINES FOR DIODE-RECTIFIER CONNECTION

KER Leading Partner: University of Strathclyde (USTRAT)

3.32.1 CHARACTERIZATION OF THE RESULT

DC grid technical competence build up	
Problem	In diode rectifier (DR) connected offshore wind farms, wind turbine (WT) converters need to operate as grid forming to control the offshore AC voltage and frequency, as well as to ensure generated power is transmitted to the DC side through the DR. Coordinating and synchronising the large numbers of WTs are critical to ensure satisfactory offshore AC voltage, frequency and power tranmission control.
Alternative solution	Methods that have been proposed use centralized control with either communication or GPS system for coordination and synchronization which lead to low system reliability
Unique Selling Point USP - Unique Value Proposition UVP	The proposed distributed PLL-based control for WT converters is completely autonomous and requires no communication among the WTs. In addition, WT synchronization is achieved using the onboard PLL (phase-locked loop) at each WT, which is much simpler and more efficient than the GPS method.
Description	The proposed method uses an additional PLL-based frequency loop to set the reference of the q-axis voltage component for frequency regulation. With the proposed control, each WT converter works autonomously to contribute to the overall offshore frequency regulation and provides WTs with plug-and-play capability when offline WTs are synchronized to the offshore network connected using diode rectifier.
"Market" – *Target market* (Customers)	Research based consultancy to WT and converter manufactureres, further international research in grid forming converter control.
Early Adopters	Wind turbine and converter manufactures, wind power plant developers, as well as grid operators.
"Market" - Competitors	DTU and UPV, who are at the same time important collaborators, SGRE, University of Rostock.
Go to Market – Use model	Main opportunities for impact are through research-based consultancy / provision of service to industries.
Go to Market – Background IPR	Experience with WT converter control, HVDC system control and protection.
Go to Market – Foreground IPR	Novel converter control strategy, fault ride through of diode rectifier HVDC system, stability assessment method of offshore network.
Go to Market	Dependent on the adoption of DR HVDC system. The method can also be used for other converter requiring grid forming operation, the time scale for this case is around 3-5 years.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	x	
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner		
		A group of partners		
	A new research project (application to public funded research programmes)	A partner	x	
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners	x	
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

3.32.2 EXPLOITATION ROADMAP

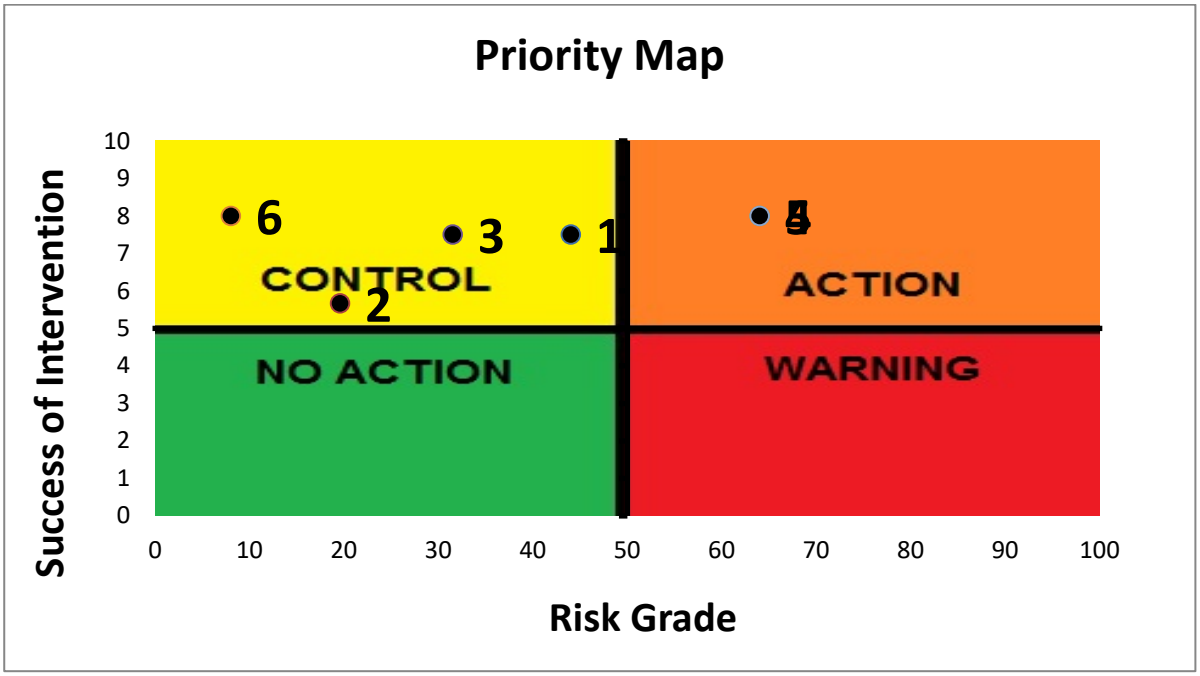
Exploitation roadmap	
Actions	PROMOTioN of the methodology among potential customers (companies and universities) / training new staff.
Roles	No other partner involved.
Milestones	2020-2021: new research contract to further develop the strategy; 2021-2022: prototype testing in commercial products
Impact in 3-years time	The adoption of the method could significantly increase the "grid friendliness" of future windfarms and thus facilitate better utilisation of renewables.
Financial costs	The main concept has already been developed as part of the project. Investment for prototype development could help further exploitation.
Revenues	The service is largely available at the end of the project. Ways to cover future cost: new contracts with companies / new research grants.
other sources of coverage	New contract with companies / new research grants for further development.

3.32.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***8***	***6***	**44,0**		***8***	**330,0**
	Disagreement on ownership rules	*8*	*4*		Legal mediation of downership disputes and patent review	*8*	
	Industrialization at risk: no manufacturer for the exploitable result.	*8*	*7*		Maintain communication with relevant stakeholders and organise hand-over and training	*7*	
2	**Technological Risk Factors**	***7***	***3***	**19,6**		***6***	**110,8**
	Worthless result: better technology/methodology exists.	*8*	*2*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*7*	
	Worthless result: earlier patent exists.	*8*	*2*		FTO study	*5*	
	Significant dependency on other technologies.	*6*	*4*		Evaluate the development of other technology and increase its applicability of the method	*5*	
3	**Market Risk Factors**	***9***	***4***	**31,5**		***8***	**236,3**
	Exploitation disagreement	*8*	*2*		discuss exploitation proposals and ensure that parappel exploitation is beneficial and in the interest of marketing the trechnology	*8*	
	Nobody buys the product. Nobody needs it.	*10*	*5*		Dissemanitation of product performance, engage with stakeholders	*7*	

	IPR/legal Risk Factors	***8***	***8***			***8***	
4	Know- how risks: it is easy to counterfeit the patent.	*8*	*8*	**64,0**	stricter control in in patent usage and aggressive pursuit of legal action	*8*	**512,0**
	Financial/management Risk Factors	***8***	***8***			***8***	
5	No resources (human and/or financial) secured to make the next step toward exploitation	*8*	*8*	**64,0**	Follow up project and additional resource	*8*	**512,0**
	Environmental/regulatory Risk Factors	***8***	***1***			***8***	
6	not in compliance with regulations	*8*	*1*	**8,0**	assessment of legal/regulatory requirements and alteration of product to comply	*8*	**64,0**

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Partnership and Technological risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act. The Partnership risks should maintain a communication with exiting expert and organised a hand over and training. Considering the Technological risk factors the technology should be re-evaluated and further optimised to match/outperform new benchmark.

Considering IPR/legal and Financial/Management risk factors have been registered at quite a high-risk grade, although with a relatively high likelihood of siucces of the planned remedy, these remedies should be followed up on.

3.33 **KER NO.33** - POLICY RECOMMENDATION/ADVICE ON HYBRID ASSET REGULATION

KER Leading Partner: RUG

3.33.1 CHARACTERIZATION OF THE RESULT

Policy recommendation/advice on hybrid asset regulation	
Problems/Issues addressed	The current regulation in EU law of (submarine) cables is based on the separation between 'interconnectors' and other grid components (including connections for offshore wind farms). Within PROMOTioN, hybrid assets and the Meshed Offshore Grid (MOG) itself intend to combine these functions, i.e. the MOG will be used both for the transmission of electricity generated at the offshore wind farms (OWFs), and for the interconnection of different countries. This combination of functions is the main added benefit of hybrid assets and the MOG, compared to the status quo (separate interconnectors and OWF connections). There are specific rules applicable to interconnectors but not to other parts of the grid, and vice versa. If the regulation is not adjusted to the mix of functions described above, the grid configuration will be suboptimal. This happens for example when the rules applicable to interconnectors are applied to the offshore grid, and the maximum capacity of the interconnector should be available to market participants without discrimination towards OWF developers directly connected to the asset. This makes it is difficult for offshore wind energy to get sufficient capacity to bring their electricity to the onshore grid – leading to over dimensioning of the grid or (unnecessary) curtailment of the OWFs.
…and how they are solved so far (Alternative solutions)	By keeping the status quo and constructing hybrid assets/MOG under the current rules. This possibility was used in the legal framework for Kriegers Flak Combined Grid Solution.Another "solution" is not building the hybrid asset, but making a radial connection or interconnector instead (eg Cobra Cable, although this was also due to other factors such as a changing business case). In other words, by avoiding the issue.
Unique Selling Point USP - Unique Value Proposition UVP	Two solutions are proposed. The first solution is adjusting the EU legislative framework to include dedicated rules on hybrid assets/MOG (this is the proposal by PROMOTioN WP7). The unique selling point of this option is that compared to the status quo, it delivers much more legal certainty for the grid developers and OWF developers connected to the grid. For a single project, such as KFCGS, it is possible to interpret the law in such a way that it fits the project, but for the massive investments that are needed for the MOG, a more solid legal basis is necessary. The unique selling point of hybrid asset regulation compared to a complete shift of the market model (option 3) is that it is possible to make more dedicated legislation for hybrid assets/the MOG, also on other issues, such as the rules on long term capacity reservation (FCA), which is beneficial for normal interconnectors but not for a MOG which is to a large extent constructed to connect OWFs. The second solution is changing the market model altogether and introding different bidding zones, in order to circumvent the clash between different rules. This can be done by using the small zones approach such as proposed in PROMOTiON WP12. The USP of this solution is that no legislative changes are needed, which means that the option can be introduced in a shorter timeframe, as long as there is political willingness for this. Another benefit is that it fits very well with the principles behind the current rules, and that it gives the right market signals to OWFs connected to a MOG.

Brief Description	Adoption of an article on offshore hybrid assets in the Electricity Market Regulation (2019/943), in which the regulatory framework for hybrid assets is clarified and which is adapted to the specific characteristics of hybrid assets. OR introduction of the small bidding zones approach as described in Deliverable 12.3.
"Market" – *Target market* (Customers)	The institution to adopt these changes is the EU, but in the legislative procedure, different parties could introduce the amendment: the European Commission; the Member States (via the Council) and the European Parliament. An intermeidate step is that if the TSOs that are concerned adopt the idea and try to bring it under the attention of the policy makers, this fortifies the message and increases the chance of success. TSOs and other hybrid asset developers are also the 'customers' in the sense that they are the beneficiaires of a better adapted legal situation for hybrid assets.
Early Adopters	TSOs that are developing hybrid assets and that run into legislative issues with the current Regulation, such as TenneT. A specific project for which adoption could be beneficial is the project Ijmuiden Ver, which has the potential to become a hybrid project if this is possible from the regulatory perspective.
"Market" - Competitors	Not applicable
Go to Market –, Use model (how the KER will be put in place)	The University will disseminate the different solutions at the governments and TSOs of the Nehterlands, Germany and Denmark, the countries most likely to use the solutions. The next step is that the TSOs adopt one or more of the proposed solutions and bring it forward to the governments and use it in their own communication to their governments and to the European Commission if applicable.
Go to Market – IPR	Not applicable
Go to Market – IPR	Not applicable
Go to Market	A few years, hopefully in time for the project Ijmuiden Ver.

Additionally:

Market size and Trends	The issue is a very specialist topic, not widely recognised as there are not so many people involved in the regulation of offshore electricity transmission assets. Nevertheless, hybrid assets are the first building blocks for a MOG, so it is important that these steps are taken in the coming few years.
Public Acceptance/social impact	In general,hybrid assets may deliver extra societal benefits compared to the status quo (interconnectors and radial connections of OWFs). Therefore, it is expected that enabling hybrid assets through regulation is positively received by the public/by industry members. Also, no negative impacts to other projects are expected from this change.

Legal or normative or ethic requirements	Adoption of hybrid asset regulation will need to follow the Ordinary Legislative Procedure of the EU. This takes several years.
Adequateness of Consortium Staff	The TSOs in the Consortium could have a large role in promoting hybrid asset solutions and bring them forward to the legislators, as mentioned above as well.
External Experts to be involved	Naturally, the governments of the countries most likely to implement hybrid assets need to be involved in order to bring this to successful completion. Without support from the relevant governments, it is not going to work.

KER's Exploitation Form					**comments**
(how the KER will be further exploited – Select only an option)					
Selected route		**Implementing actor**	**Yes**	**No**	
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		x	
		A group of partners		x	
	Contract research (new contracts signed by the research group with external clients)	A partner		x	
		A group of partners		x	
	A new research project (application to public funded research programmes)	A partner	x		The University used the experience from PROMOTioN to participate in a call from the Dutch Scientific Organisation (NWO), which was awarded to us. This project will lead to a new PhD on North Sea energy and law topics
		A group of partners		x	
	Implementation of a new university - course (Note that a training course is a service)	A partner	x*		Not an entirely new course, but the knowledge and experience developed within PROMOTioN is used to give specific lectures within existing courses and training programmes
		A group of partners		x	
		A new partnership		x	

INDIRECT USE	Transfer of ownership (IPR)	A partner		x	
		A group of partners		x	
	Licensing IPR	A partner		x	
		A group of partners		x	
	Development of a new legislation/standard	A partner	x		This is the KER that is further elaborated in this form
		A group of partners	x		
	Spin- off	A partner		x	
		A group of partners		x	
		By assignment		x	
		By licensing		x	
	Other (please describe)			x	

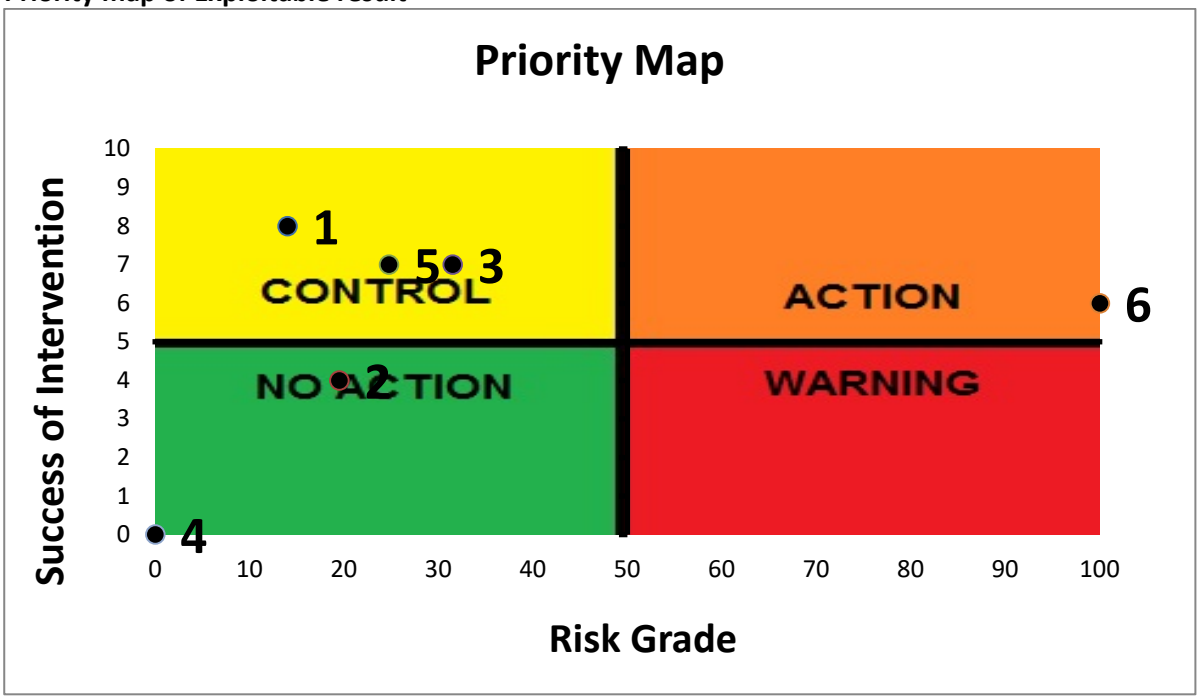
3.33.2 EXPLOITATION ROADMAP

Exploitation roadmap	
Actions	*Presentation of the results at various venues, with the aim of TSOs and policy-makers taking over the results and bringing them to practice*
Roles	*RUG and TU Delft (Laurens de Vries) have a role in communicating their results; TSO project partners have a role in bringing the ideas further.*
Milestones	*1. TSOs take over the recommendations 2. National policy-makers take over the recommendations 3. European Commission take over the recommendations. These can be monitored by looking at the responses to presentation of the results (positive/negative) and follow-up questions.*
Impact in 3-years time	*European Commission and Member-States have noticed the need for policy change and actively pursue the required changes.*
Financial costs	*No specific costs, except perhaps incidentally travel costs*
Revenues	*No revenues*
other sources of coverage	*No need for coverage*

3.33.3 RISK MATRIX

Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
Partnership Risk Factors	***7***	***2***	**14,0**		***8***	**112,0**
Partner stops to cooperate on exploitation	*7*	*2*		Make clear agreements and a concrete plan	*8*	
Technological Risk Factors	***7***	***3***	**19,5**		***4***	**78,0**
Significant dependency on other technologies.	*8*	*3*		Hope that the others in the consortium perform well	*1*	
The life cycle of the new technology is too short.	*5*	*3*		Speed up with implementation of legal changes	*7*	
Market Risk Factors	***9***	***4***	**31,5**		***7***	**220,5**
Worthless result: performance lower than market needs.	*9*	*2*		Listen well to the stakeholders that need to use the policy change, listen to their needs	*7*	
Nobody buys the product. Nobody needs it.	*9*	*5*		More dissemination of what the urgency of the solution is	*7*	
Financial/management Risk Factors	***6***	***5***	**24,8**		***7***	**173,3**
Multiple changes to original objectives.	*8*	*6*		Make the solution able to adapt to changing legal circumstances	*6*	
Lack of endorsement from top management	*3*	*3*		Do it anyway	*8*	
Environmental/regulatory Risk Factors	***10***	***10***	**100,0**		***6***	**600,0**
Influence of laws and regulations.	*10*	*10*		Make the solution able to adapt to changing legal circumstances	*6*	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Partnership, Financial/management and Market risk factors present a low-risk grade coupled with a high probability of success of the planned remedy. Some situations are identified where it would be preferable to keep an eye on, monitoring regularly (Control) to be ready to act.

IPR/Legal Risks and Technological risks have a very low risk grade. On the other hand, Environmental risk is high with a medium probability of success with intervention. This factor should be followed up on.

3.34 **KER NO.34** - BLACKSTART ENABLED GRID CONNECTED WIND TURBINES FOR OFFSHORE WIND PARKS

KER Leading Partner: MHI Vestas Offshore Wind AS (MVOW)

3.34.1 CHARACTERIZATION OF THE RESULT

Blackstart enabled grid connected wind turbines for offshore wind parks	
Problem	With increasing numbers of large offshore wind parks being connected, option of using wind turbine based Blackstart capability and auxilliary back-up power support for offshore substations is being required by TSOs and Developers. Contribute in creating standards for Blackstart using offshore wind.
Alternative solution	Blackstart for onshore is currently provided by designated warm-running gas power plants.
Unique Selling Point USP - Unique Value Proposition UVP	Blackstart capabale wind turbines substitute fossil based warm running power plants, saving on fossil fuel costs and OPEX costs and CO_2 emissions.
Description	Conventional/current grid connected wind turbnies are based on grid following converter technology requiring a stiff grid with steady voltage and frequency. Blackstart compliant wind turbines need to change to grid forming converter technology, creating a voltage and frequency into a dead grid and power-up in block loads.
"Market" – *Target market* (Customers)	All major TSOs in countries where offshore wind parks are connected. Developers involved in weak grid markets.
Early Adopters	Potentially all TSOs (e.g National Grid UK, Energinet, DK, Tennet) will be keen users of Blackstart using green offshore wind.
"Market" - Competitors	All major offshore wind OEMs.
Go to Market – Use model	Reducing cost of security of supply and early reach of lowering CO_2 targets for countries and regions. Increased market area adding countries with relatve weak grids - enabling large offshore wind energy connections.
Go to Market – IPR	N/A
Go to Market – IPR	N/A
Go to Market	3 to 5 years

KER's Exploitation Form
(how the KER will be further exploited – Select only an option)

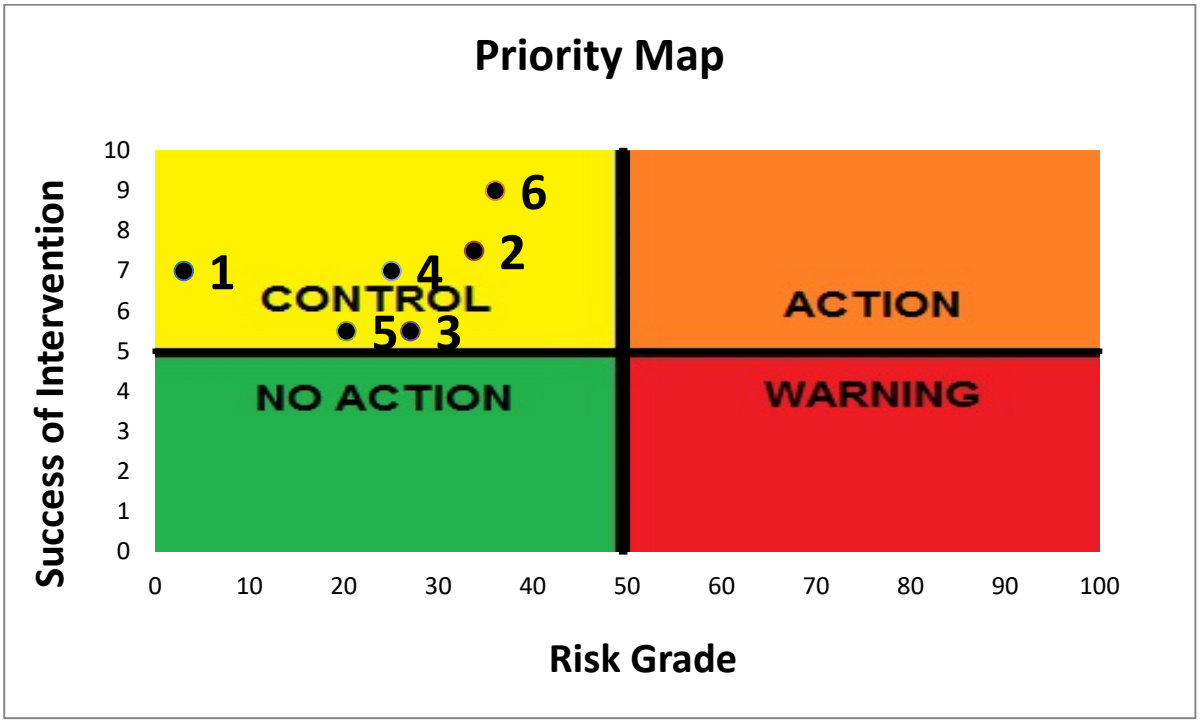
Selected route		Implementing actor	Yes	No
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	x	
		A group of partners		x
	Contract research (new contracts signed by the research group with external clients)	A partner		x
		A group of partners		x
	A new research project (application to public funded research programmes)	A partner		x
		A group of partners		x
	Implementation of a new university - course (Note that a training course is a service)	A partner		x
		A group of partners		x
		A new partnership		x
INDIRECT USE	Transfer of ownership (IPR)	A partner		x
		A group of partners		x
	Licensing IPR	A partner		x
		A group of partners		x
	Development of a new legislation/standard	A partner		x
		A group of partners	x	
	Spin- off	A partner		x
		A group of partners		x
		By assignment		x
		By licensing		x
	Other (please describe)			x

3.34.2 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	**3**	**1**			**7**	
	Industrialization at risk: no manufacturer for the exploitable result.	3	1	**3,0**	do thorough feasibility and return of investment and formulate and agreement for industrialisation along with a proof-of-concept	7	**21,0**
2	**Technological Risk Factors**	**8**	**5**			**8**	
	better technology emerges	7	4		Re-evaluation of technology and further optimisation to match/outperform new benchmark	8	
	limited market (flow limitations)	8	5	**33,8**	correctly assess existing market technologies and assess performance and ability to penetrate market through replacement in exisiting applications	7	**253,1**
3	**Market Risk Factors**	**6**	**5**			**6**	
	Nobody buys the product. Standards to make it compulsory don't yet exist.	7	5		make early agreements with potential customers and agree on payment mechanisms	5	
	difficulty in market penetration/customer reception and acceptance of technology	5	4	**27,0**	additional market studies, customer surveys and assessment of product shortfalls	6	**148,5**

4	**IPR/legal Risk Factors**	**5**	**5**			**7**	
	competitors replicate technology	5	5	**25,0**	stricter control in in patent usage and aggressive pursuit of legal action	7	**175,0**
5	Financial/management Risk Factors	5	5			6	
	No resources (human and/or financial) secured to make the next step toward exploitation	5	5	20,3	make early level resource planing matched with market appetite for the feature	5	**111,4**
	Weak exploitation: Inadequate business plan	4	4		make early effort to complete a robust business plan with adequate risk management	6	
6	**Environmental/regulatory Risk Factors**	**6**	**6**			**9**	
	Influence of laws and regulations.	6	6	**36,0**	in the absense of a mature regulatory framenwork, make a pro-active effort collaborating with partners in makinng necessary regulatory sandards	9	**324,0**

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

3.35 **KER NO.35** - EXTENDED CBA METHODOLOGY

KER Leading Partner: ENERGINET.DK

3.35.1 CHARACTERIZATION OF THE RESULT

Extended CBA Methodology	
Problem	To understand the economic and social consequences of undertaking an offshore grid development in a region or country, it is necessary to perform a cost-benefit (CB)-analysis to assess the value and cost of an offshore grid/asset/(hybrid) project. In order to perform this CB-analysis, a CBA methodology should be employed that sets out a clear set of guidelines to ensure a thorough assessment and comparison of alternative offshore solutions. Current methodologies are mostly insufficient when assessing complex systems such as offshore grids or hybrid (electricity/gas) projects. The development moves more and more towards hybrid offshore electricity assets (example: Kriegers Flak or the North Sea Wind Power Hub concept) or projects combining electricity and gas infrastructure. Therefore, the identified problem is significant.
Alternative solution	So far transmission grid solutions (interconnectors) have been assessed based on the acknowledged methodology as presented by ENTSO-E (surplus- or least cost method). However, complex offshore solutions or hybrid projects (hubs with combined electricity and gas/hydrogen transmission) cannot be assessed sufficiently from a socio-economic perspective by the current methodology.
Unique Selling Point USP - Unique Value Proposition UVP	The added value of the extended CBA methodology is that it provides TSO's and other relevant stakeholders/customers with a framework that evaluates the (societal) costs and benefits of hybrid projects on additional parameters and thereby provide robustness in investment decision processes.
Description	An extended CBA methodology for assessing offshore grid solutions, hybrid projects etc.
"Market" – Target market (Customers)	Can be used by e.g. TSOs (and other developers) for offshore grid planning and investment. Potentially, the solution has global potential with the users located worldwide.
Early Adopters	European TSOs and offshore developers since the offshore development in Europe are moving rapidly. The extended CBA methodology can be further developed under a collaboration within ENTSO-E/G (European Network of Transmission System Operators for Electricity/Gas).
"Market" – Competitors	/not relevant/ for a public, regulated TSO as Energinet.
Go to Market – Use model	The extended CBA methodology can be "open source" and should be developed jointly by European TSO's. If agreed upon amongst the TSO's, the extended CBA methodology can be the new best practice for assessing offshore hybrid assets/projects.
Go to Market – IPR	Not relevant since the extended CBA methodology is an openly available and published method.
Go to Market – IPR	Not relevant since the extended CBA methodology is an openly available and published method.
Go to Market	Further research and development needed. Time to market estimation: 2-4 years.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner		x
		A group of partners		x
	Contract research (new contracts signed by the research group with external clients)	A partner		x
		A group of partners		x
	A new research project (application to public funded research programmes)	A partner		x
		A group of partners		x
	Implementation of a new university - course (Note that a training course is a service)	A partner		x
		A group of partners		x
		A new partnership		x
INDIRECT USE	Transfer of ownership (IPR)	A partner		x
		A group of partners		x
	Licensing IPR	A partner		x
		A group of partners		x
	Development of a new legislation/standard	A partner		x
		A group of partners		x
	Spin- off	A partner		x
		A group of partners		x
		By assignment		x
		By licensing		x
	Other: Knowledge/competence build-up	No partner	x	

3.35.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	Building further upon the knowledge gained in PROMOTioN e.g. use it for other, coming projects within the organisation.
Roles	Energinet.
Milestones	
Impact in 3-years' time	Should help Energinet decide on projects which generates the highest societal value.
Financial costs	n/a
Revenues	For use internally and thereby covered by our own budget.
other sources of coverage	n/a

3.35.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	*1*	*1*			*1*	
	Disagreement on ownership rules	*1*	*1*		Legal mediation of ownership disputes and patent review	*1*	
	Industrialization at risk: a partner declares bankruptcy.	*1*	*1*	**1,0**	initiate consortium meeting to explain usage issues and redefine roadmap of exploitation	*1*	**1,0**
	Industrialization at risk: a partner declares bankruptcy.	*1*	*1*		maintain communication with exiting expert and organise hand-over and training		
2	**Technological Risk Factors**	*1*	*1*			*1*	
	better technology emerges	*1*	*1*		Re-evaluation of technology and further optimisation to match/outperform new benchmark	*1*	
	limited market (flow limitations)	*1*	*1*	**1,0**	redesign of valve configuration to enhance range of device	*1*	**1,0**
	valves aim to replace existing mechanical counterparts	*1*	*1*		correctly assess existing market technologies and assess performance and ability to penetrate market through replacement in existing applications	*1*	
3	**Market Risk Factors**	*1*	*1*			*1*	
	Exploitation disagreement	*1*	*1*		discuss exploitation proposals and ensure that parallel exploitation is beneficial and in the interest of marketing the technology	*1*	
	difficulty in market penetration/customer reception and acceptance of technology	*1*	*1*	**1,0**	additional market studies, customer surveys and assessment of product shortfalls	*1*	**1,0**
4	**IPR/legal Risk Factors**	*1*	*1*			*1*	
	competitors replicate technology	*1*	*1*	**1,0**	stricter control in in patent usage and aggressive pursuit of legal action	*1*	**1,0**
5	**Financial/management Risk Factors**	*1*	*1*	**1,0**		*1*	**1,0**

	weak exploitation of the material	*1*	*1*		revision of exploitation plan and market research and relaunch of product	*1*	
6	**Environmental/regulatory Risk Factors**	*3*	*3*	**9,0**		*2*	**18,0**
	not in compliance with regulations	*3*	*3*		assessment of legal/regulatory requirements and alteration of product to comply	*2*	

Priority map of Exploitable result

Legend:

7. Partnership Risks
8. Technological Risks
9. Market Risks
10. IPR/legal Risks
11. Financial/Management risks factors
12. Environmental risks factors

Priority Map for the project

The Partnership, Technological, Market, IPR/legal, Financial and Environmental risk factors have a low-risk grade and a low probability of success for the remedy, it is a situation does not call for immediate action (no action).

3.36 **KER NO.36** - HVDC CONTROL HARDWARE IN-THE-LOOP TEST ENVIRONMENT

KER Leading Partner: SHE Transmission

3.36.1 CHARACTERIZATION OF THE RESULT

HVDC Control Hardware In-the-Loop Test Environment	
Problem	• TSOs and manufacturers have very limited experience with the operation of MTDC (Multi-Terminal Direct Current) systems as there is only one multi-terminal HVDC grid in operation today based on VSC technology, which is located in China; • There is insufficient knowledge regarding the interaction of MTDC systems with the AC (alternating current) transmission system and the offshore WPPs (wind power plants) while these interactions should be already taken into account when MTDC systems are designed, not thereafter; • The control and protection concepts are typically developed using offline simulations, but need to be demonstrated before the system is manufactured; • Testing and validations of new control and protection concepts or approaches on real MTDC system are very costly and currently impracticable.
Alternative solution	• The MMC test bench which allows real-time simulation using a Power hardware in-the-loop (PHIL) approach provided by Aachen
Unique Selling Point USP - Unique Value Proposition UVP	Being part of a TSO there is access to priveledged information for the UK transmission network that alternative providers of a real-timetesting facility would not have direct access to. Gaining a selection of Replica Control and Protection cubicles for HVDC schemes connecting to GB which can be used to check for interactions or integrated with potential scheme alterations to check performance. As a consequence of this can give project specific conclusions.
Description	The HVDC Centre is an Ofgem funded simulation and training facility established in 2017 to support all HVDC schemes either already in operation or in development. It is intended to manage individual HVDC project risks as well as ensuring the integrity and security of the grid network, as increasing numbers of HVDC schemes connect to the GB grid. The HVDC Centre has installed replica control hardware for a multi-terminal enabled HVDC scheme under construction in the north of Scotland, the Caithness-Moray HVDC project, (CM Project). This enables real-time modelling to resolve potential issues and mitigate any impact on the delivery and operation of the CM project. To perform any studies using the replica equipment, a real-time simulator (RTS) is required. This is a combination of hardware and software which allows the replicas to operate as if connected to the real system. An RTS allows the testing and operation of the actual/replica controllers in real-time (known as 'hardware-in-the-loop' [HIL]). The HVDC Centre uses RTDS® Technologies simulator hardware, with the RSCAD software. The hardware (currently) comprises: o 6 x NovaCor chassis (RTDS®'s latest generation hardware); o 3 x RTDS Racks, each including (5 x PB5 cards, 1 x GTWIF); o 12 x MMC Support Units (to simulate the valves); o A GTSYNC card (to synchronise simulations); and o A range of input/output cards: GTNETx2, GTAO, GTAI, GTDO and GTDI. This provides significant simulation capability, both in terms of simulated network size and complexity.

"Market" – Target market (Customers)	Exploitation: • Research progress : Strengthening the industry knowledge and confidence in this field (real-time PHIL simulations for HVDC systems). Demonstration of developed concepts. Leading to Bigger solution tool box for developers/TSOs/etc • Offering services to TSOs, developers (OFTO/offshore wind/interconnector) and manufacturers. The focus lays on the European market with its three HVDC manufactures and relevant TSOs with planned HVDC systems (more than 10 TSOs until 2025), while but it is not limited to it.
Early Adopters	Researchers, developers and European TSOs with an interest in integration of MTDC systems.
"Market" - Competitors	The use of control and power hardware in the loop has been proposed and implemented before for the investigation of HVDC converters by other research institutions and universities, like Supergrid institute, SINTEF, Imperial college London and the university of Lille. These institutions do have an advantage as they have already gained experience with operating such systems. None of the competitirs would have the access to the network information and (on the assumption that we have multiple Replcias from multiple UK projects) the ability to check the interaction impacts.
Go to Market – Use model	Additional service offering expanding on the real-time simualtion abilities already available.
Go to Market – IPR	Previously existing expertise in HVDC control and protection strategies and AC grid modelling for dynamic simulations.
Go to Market – IPR	Development of competancies, models and study methodologies. Avaialbility of protection designs which can be tested.
Go to Market	Available to offer the new competanices now.

KER's Exploitation Form				
(how the KER will be further exploited – Select only an option)				
Selected route		**Implementing actor**	**Yes**	**No**
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	x	
		A group of partners		
	Contract research (new contracts signed by the research group with external clients)	A partner		
		A group of partners		
	A new research project (application to public funded research programmes)	A partner		
		A group of partners		
	Implementation of a new university - course (Note that a training course is a service)	A partner		
		A group of partners		
		A new partnership		
INDIRECT USE	Transfer of ownership (IPR)	A partner		
		A group of partners		
	Licensing IPR	A partner		
		A group of partners		
	Development of a new legislation/standard	A partner		
		A group of partners		
	Spin- off	A partner		
		A group of partners		
		By assignment		
		By licensing		
	Other (please describe)			

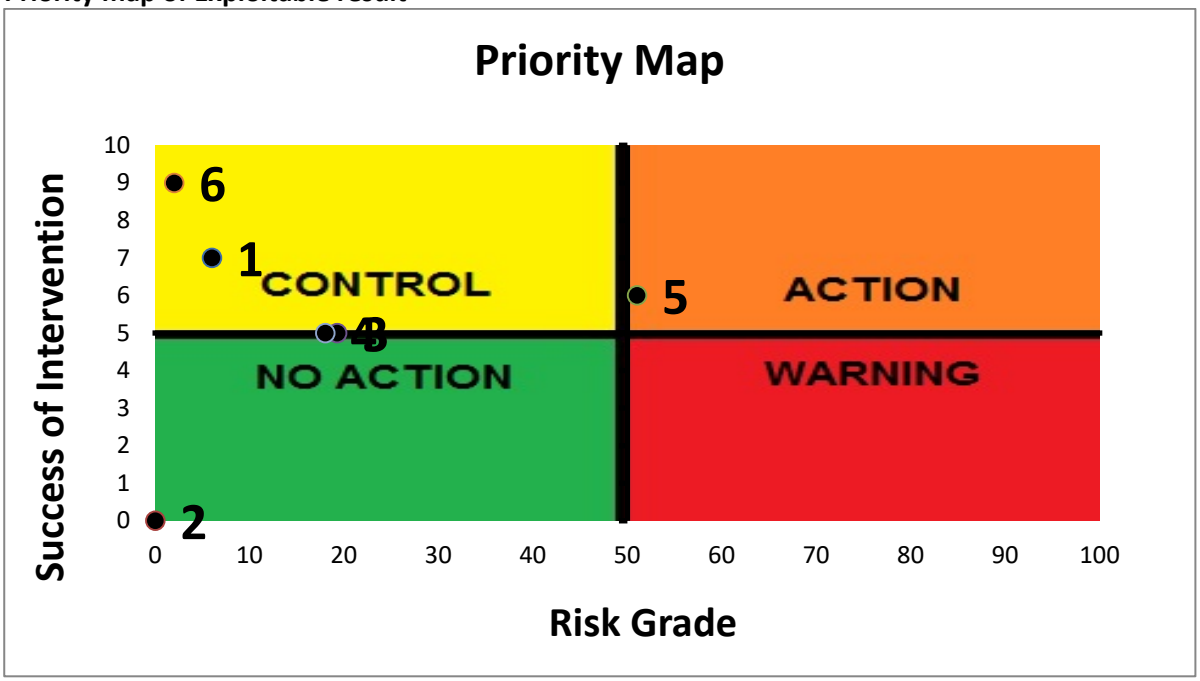
3.36.2 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	Raise awareness of capabilities to early adopters by continuing to give international exposure to the results obtained. Multi-terminal protection is one example of supplimentary controls for which we could provide a testing platform for, as such this gives further evidence of our testing capabilities even if it isn't for HVDC grids.
Roles	Potential for continued co-operation with our key project partners KTH and Mitsubishi for continued use of prototypes for demos and KUL for the development of testing methodologies.
Milestones	Commisioning of further testing of additional controllers for HVDC (grids or otherwise). Service is available and awaiting sign up of clients - milestone would be signing of contracts for additional work. After contracting for additional work the staff recruitment would occur.
Impact in 3-year time	Greater update of this kind of testing expected to create a further 4 jobs for specialist engineers across the next 3 years. By doing more of this testing we expect to de-risk and potentially speed up the use of HVDC for integration of renewables into the UK.
Financial costs	Investment in people and additional facility space is covered as part of our existing remit to de-risk integration of HVDC in the UK.
Revenues	Continued OFGEM funding Costs covered, any extra revenue returned to the consumer. For specific HVDC projects (this could be TSO, developer or inerconnector), it would be offered as a service to be reinbursed by that user. Currently there is little market for this.
Other sources of coverage	Time to market for the service developed in PROMOTioN is zero, the service is available. The spin-off, HVDC grid protection system testing will be part of our service offering.

3.36.3 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	**3**	**2**	**6,0**		**7**	**42,0**
	Disagreement on ownership rules	3	2		Legal mediation of ownership disputes and patent review	7	
3	**Market Risk Factors**	**6**	**4**	**19,3**		**5**	**96,3**
	Exploitation disagreement	3	2		discuss exploitation proposals and ensure that parappel exploitation is beneficial and in the interest of marketing the trechnology	5	
	difficulty in market penetration/customer reception and acceptance of technology	8	5		additional market studies, customer surveys and assessment of product shortfalls	5	
4	**IPR/legal Risk Factors**	**2**	**9**	**18,0**		**5**	**90,0**
	competitors replicate technology	2	9		USP is more with regards to the position to the specific market, others would be able to follow the methodology but potentially not have access to repliacs etc	5	
5	**Financial/management Risk Factors**	**9**	**6**	**51,0**		**6**	**306,0**
	weak exploitation of the material	9	7		revision of exploitation plan and market research and relaunch of product	5	
	No resources (human and/or financial) secured to make the next step toward exploitation	8	5		Engage with resources internal and extrenal to maintain and keep in house knowledge	7	
6	**Environmental/regulatory Risk Factors**	**2**	**1**	**2,0**		**9**	**18,0**
	not in compliance with regulations	2	1		assessment of legal/regulatory requirements and alteration of product to comply	9	

Priority map of Exploitable result



Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

Risk factors 1-4 and 6 either have a very low risk grade or have a high probability of success with intervention. In order to make sure that the result is exploited, these risks should be monitored and interventions should be made if necessary.

The Financial/Mangement risk factor is quite high. Interventions should be made if it is likely that they will have a positive effect on the realization of the exploitation of the result.

3.37 **KER NO.37** - LAB-PROVEN PERFORMANCE OF VOLTAGE SOURCE CONVERTER (VSC) - ASSISTED CIRCUIT BREAKER

KER Leading Partner: SCiBreak

3.37.1 CHARACTERIZATION OF THE RESULT

LAB-Proven Performance of Voltage Source- Converter (VSC)-Assisted Circuit Breaker	
Problem	Lack of a cost-efficient DC circuit-breaker for deployment in meshed HVDC grids.
Alternative solution	The workaround is to only build point-to-point links, that don't require breakers. A breaker-based solution has not yet been implemented. Although other companies than SCiBreak also offer DC circuit-breakers, we believe that our technology will be the most cost-efficient way to reach required performance of the circuit-breaker. Another solution is full-bridge converter stations with AC-breakers.
Unique Selling Point USP - Unique Value Proposition UVP	SCiBreak's solution offers a unique combination of performance, i.e. fast interruption and cost, for medium and high voltage breakers. The fast interruption reduces costs of other components in the system. In addition to this, based on the components required for the breaker, it should be possible to offer the circuit-breaker at significantly lower price than the competition. SCiBreak's impression of the customer need is that a fast circuit-breaker at much lower cost than that of a converter station is required. The SCiBreak breaker can be faster than an active current injection breaker, and cheaper than a hybrid breaker. Offering a different breaker topology with different trade-off cost/performance is in itself a USP.
Description	SCiBreak offers an ultra-fast circuit breaker in a modularized concept, that can be extended to any voltage level.
"Market" – *Target market* (Customers)	SCiBreak will compete both in the market for DC circuit-breakers in HVDC and in MVDC. The breaker also has applications in AC systems as an ultra-fast, current limiting circuit-breaker. The prospective customers in HVDC are primarily national grid operators, but also other technology companies that would like to offer SCiBreak's technology. SCiBreak would then sell at least licenses to use the IPR, but also possibly know-how and designs. Off-shore wind-farms in Europe could be an attractive early application.
Early Adopters	Off-shore wind is identified as a potential early market, as there is t a clear advantage to dc-transmission and a need for dc-breakers in a relatively low voltage range (<100kV). We also hope that SvK and TenneT will be early adopters of our technology.
"Market" - Competitors	In the HVDC circuit-breaker market, our competitors are ABB, Mitsubishi and GE. We believe that a circuit-breaker should be very fast, less than 3 ms until neutralization, if not faster. SCiBreak's circuit breaker, the VARC, can do this at a significantly lower cost than the competing solutions.
Go to Market – Use model	SCiBreak will seek to sell circuit-breakers directly, if the volume and breaker rating is low, and to sell licenses for the manufacturing of larger volumes. Selling know-how and designs is also possible in the case that a customer purchases a license. The main issue in HVDC is that any new projects require large investments, so naturally the development is slow. Standards so far only exist in China. There are no clear ethical or legal issues related to circuit-breakers. General public seems to believe that circuit-breakers are prohibitively expensive - this is something we seek to challenge whenever we can. The cost of a high-performance circuit-breaker should be below 10% of the cost of the half-bridge MMC converter.
Go to Market – IPR	An international patent covering the fundamental technology, and several other patents covering specific parts of the innovation, are already held by SCiBreak.

Go to Market – IPR	No foreground IPR. The DC breaker technology is already developed and owned by SCiBreak. Within PROMOTioN, only IPR related to testing, reporting etc. is produced.
Go to Market	2 years after project completion.

3.37.2 EXPLOITATION FORM

KER's Exploitation Form					Remarks
Selected route		**Implementing actor**	**Yes**	**No**	
DIRECT USE	Commercialisation: deployment of a novel product/service (offered to the target markets)	One partner	X		SCIBreak provides HVDC breaker.
		A group of partners			
	Contract research (new contracts signed by the research group with external clients)	A partner			
		A group of partners			
	A new research project (application to public funded research programmes)	A partner			
		A group of partners	X		We welcome any new common research projects in HVDC breakers or their applications.
	Implementation of a new university - course (Note that a training course is a service)	A partner			
		A group of partners			
		A new partnership			Would be possible for us to contribute to course at KTH, KUL or other partner
INDIRECT USE	Transfer of ownership (IPR)	A partner			
		A group of partners			
	Licensing IPR	A partner	X		We are willing to discuss licensing with interested parties.
		A group of partners			
	Development of a new legislation/standard	A partner			
		A group of partners	X		We are participating in relevant standaridsation bodies
	Spin- off	A partner			
		A group of partners			
		By assignment			
		By licensing			
	Other (please describe)				

3.37.3 EXPLOITATION ROADMAP

Exploitation Roadmap	
Actions	Create interest group (TSOs, manufacturers, consultants) to work towards onshore breaker pilot installation in Europe, initially linking two point-to-point HVDC links.
Roles	TSOs: buyers. SCiBreak: provider of breaker component. E.g. CESI/KEMA: testing and certification. E.g. DNV GL: engineering, system verification.
Milestones	1. Modular VARC HVDC breaker tested at KEMA. 2. Business case for three-terminal pilot HVDC system with breaker established and agreed aming concerned parties. 3. Pilot three-terminal HVDC system in operation
Impact in 3-year-time	First HVDC breaker installation in Europe paving the way towards HVDC grids.
Financials **Costs**	Sensitive, prefer not to answer. Cost of hardware is a highly contentious issue in the HVDC industry and in PROMOTioN stating cost or price figues has not been allowed.
Revenues	Sensitive, prefer not to answer. Cost of hardware is a highly contentious issue in the HVDC industry and in PROMOTioN stating cost or price figues has not been allowed.
Other sources of coverage	Initially, governmental, or EU, support is likely to be needed to kick things off.

3.37.4 RISK MATRIX

	Key Exploitable Results	Degree of importance of the risk related to the final achievement of this Key Exploitable Result. (1 low- 10 high)	Probability of risk happening (1 low - 10 high)	Risk Grade	Scope and type of potential intervention	Feasibility/Success of Intervention (1 low- 10 high)	Priority Level
1	**Partnership Risk Factors**	***8***	***4***	**32**		***5***	**160**
	Unable to find a suitable partner	*8*	*4*		Socialize more	*5*	
2	**Technological Risk Factors**	***10***	***2***	**20**		***5***	**100**
	Better technology emerges	*10*	*2*		Keep track of competition, screening, faster to market, move to different market, customer validation	*5*	
3	**Market Risk Factors**	***8***	***8***	**64**		***6***	**384**
	Difficulty in market penetration/customer reception and acceptance of technology	*8*	*8*		Pilot installation	*6*	
4	**IPR/legal Risk Factors**	***8***	***4***	**30**		***4***	**120**
	Competitors circumvent patents	*5*	*3*		Decrease time to market, new patents	*3*	
	Legal problems	*10*	*5*		Find larger potential partners that could help	*5*	
5	**Financial/management Risk Factors**	***8***	***2***	**16**		***7***	**112**
	Weak exploitation: Inadequate business plan	*8*	*2*		Revision of exploitation plan and market research and relaunch of product	*7*	
	No resources (human and/or financial) secured to make the next step toward exploitation	*8*	*2*		Raise neccessary fund for development. Team up with other interested parties.	*7*	
6	**Environmental/regulatory Risk Factors**	***8***	***8***	**40**		***3***	**120**
	Influence of laws and regulations.	*5*	*5*		Carefully monitor the development of development of laws and regulations and adapt the marketing actions.	*3*	

Priority map of Exploitable result

Legend:

1. Partnership Risks
2. Technological Risks
3. Market Risks
4. IPR/legal Risks
5. Financial/Management risks factors
6. Environmental risks factors

Discussion of the Priority Map for the project

The Partnership and Technological risks present a situation between Control and No action, where is a low risk grade with a medium probability of success of the planned remedy.

The Market risk factors present a high-risk grade with a high probability of success for the remedy action defines a situation where there is the need for an immediate action to ensure exploitation (action). In a market that is difficult to penetrate or have the customer reception a possible intervention should be a pilot installation.

The IPR/legal risk factors present a low-risk grade and a low probability of success for the remedy, it is a situation does not call for immediate action (no action).

The Financial/Management and Environmental risk factors should be filled in the Risk Matrix tool in order to evaluate the risk level and to find a possible intervention

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4 CONTRIBUTION TO THE PROJECT'S OBJECTIVES

PROMOTioN has been addressing the challenges for meshed HVDC offshore networks development by putting a clear focus on six ambitious objectives from its beginning in 2016. The guiding principle behind these objectives is the search to bring meshed HVDC offshore grids and their associated technologies to the level of large scale real-life application. Successfully addressing these six objectives will significantly accelerate the deployment of meshed HVDC offshore grids in the North Sea area and beyond towards continental power corridors and will be a major step in bringing them into commercial application in the near future. These six core objectives are:

1. To establish interoperability between different technologies and concepts by providing specific technical and operational requirements, behaviour patterns and standardization methods for different technologies
2. To develop interoperable, reliable and cost-effective technology of protection for meshed HVDC offshore grids and the new type of offshore converter for wind power integration
3. To demonstrate different cost-effective key technologies for meshed HVDC offshore grids and to increase their technology readiness level by investigating and overcoming early adopter issues and pitfalls
4. To develop a new EU regulatory framework, both in accordance with EU wide energy policy objectives and those of the Member States, and to increase the economic viability of meshed HVDC projects by providing a suitable financial framework
5. To facilitating the harmonization of ongoing initiatives, common system interfaces and future standards by actively engaging with working groups and standardization bodies and actively using experience from the demonstrations.
6. To provide concrete deployment plan for "phase two" in bringing key technologies for meshed HVDC offshore grids into commercial operation in Europe, taking into account technical, financial and regulatory aspects

In the table below the 37 KERs are indicatively and individually scored on their contributions to these different objectives. Some KERs contribute in several objective areas; a fat **x** is used when one objective clearly stands out for the respective KER contribution.

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			Objectives					
SHORT NAME	**KER #**	**Type of exploitation**	1	2	3	4	5	6
DNV GL	1	Service	x			**x**		
KEMA	2	Service	x	x	**x**			
ABB	3	Product			x			
KU Leuven	4-7	Service Development of a new standard Further research/ education		x		 x	x	
KTH	8	Product/further research	x	**x**				
EirGrid	9	Increased knowledge		**x**	**x**			
SGI	10-12	Services/ Products/ Further contract research	 x x	 **x** **x**	x **x** x			
DWG	13	Service				x		x
MEU	14-15	Products	x	**x**	**x**			
Svk	16	Increased knowledge		**x**	**x**			x
UniAbdn	17	Patent		x				
RTE	18	Development of a new standard					x	
TU Delft	19	Services		x				
Equinor	20	Increased knowledge	**x**					x
SOW	21	Consultancy services	x	x	x	x	x	x
Siemens	22	Increased knowledge			x			
DTU	23	Service	x				x	
RWTH Aachen	24	Service	**x**	x	x			
UPV	25	Contract research	**x**	x	x			
FGH	26	Product/Service - software	x					x
Ørsted	27	Development of a new standard					x	
Carbon Trust	28	Consultancy services	x	x				

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Tractebel	29	Consultancy services	x					**x**
EUI	30	Policy recommendation				x		
T&D Europe	31	Increased knowledge and competence			x			x
USTRAT	32	Service		x	x			
RUG	33	Policy recommendation				x		
MVOW	34	Development of a new standard					x	
Energinet	35	Increased knowledge	x			**x**		
SHE Transmission	36	Services	**x**	x	x			
SCiBreak	37	Product			x			

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5 ABBREVIATIONS

AC	Alternating Current
AIS	Air-Insulated Switchgear
B2B	Business to Business
B2C	Business to Consumer
B2T	Business to Technology
BMWi	German Federal Ministry of Economic Affairs and Energy
BRP	Balancing Responsible Party
BSH	German Federal Maritime and Dydrographic Agency
BSP	Balancing Service Provider
CB	Circuit Breaker
CBA	Cost Benefit Analyses
CGI	Controllable Grid Interface
DC	Direct Current
DC CB	Direct Current Circuit Breaker
DCG	Dierct Current Grid
DC-GIS	Direct Current Gas-Insulated Switch
DR	Diode Rectifier
DRU	Diode Rectifier Unit
EEZ	Exclusive Economic Zone
EPC	Engineering Procurement and Construction
ESCI	European Science Communication Institute
ESS	Exploitation Strategy Seminar
FEM	Finite Element Method
FEP	German Marine Spatial Planning
FLW JIP	Floating Offshore Wind Joint Industry Project
FTE	Full Time Equivalent
FTO	Freedom-to-Operate
GIS	Gas-Insulated Switch
GPS	Global Positioning System
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
HVDC-GIS	High Voltage Direct Current Gas-Insulated Switch
IED	Intelligent Electronic Device
IPR	Intellectual Property Rights
KER	Key exploitable result
MMC	Multilevel Modular Converter

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MOG	Meshed Offshore Grid
MOSA	Metal Oxide Surge Arrestor
MSc	Master of Science
MTDC	Multi-Terminal Direct Current
MVDC	Mid Voltage Direct Current
MVA	Mega Volt Ampere
MW	Mega Watt
OEM	Origina Equipment Manufacturer
OFTO	Offshore Transmission Owner
OPF	Optimal Power Flow
OWA	Offshore wind accelerator
OSW	Offshore wind
OWF	Offshore wind farm
P2P	Point-To-Point
PD	Partial Discharge
PhD	Doctor of Philosphy
PHIL	Power hardware in-the-loop
PLL	Phase-locked loop
POC	Proof of Concept
R&D	Research & development
REN	Renewable Energy
RES	Renewable Energy Sources
RSC	Regional Security Coordiantor
SA	Surge Arrester
SCOPF	Security Constrained Optimal Powr Flow
SME	Small and Medium-sized Enterprise
SSERR	Support Services of Exploitation of Research Results
TRL	Technology Readiness Level
TSO	Transmission System Operators
USP	Unique Selling Point
UVP	Unique Value Proposition
VARC	VSC Assisted Resonant Current
VSC	Vehicle Stability control
WPP	Wind Power Plant
WT	Wind Turbine

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ANNEX: ESS RECOMMENDATIONS

Issues	Recommendations
Use of acronyms	Please, for the sake of clearness and understandability, avoid as much possible the use of acronyms, moreover when naming a key exploitable result.
Characterisation of KERs	The ESS helped the partners to better understand how exploitation needs to be addressed. It is recommended that the Coordinator, which acts as Exploitation Manager, makes sure that what was discussed during the seminar is further developed, validated and integrated in the next release of the exploitation plan. It is also suggested that, to develop and validate information, partners involve colleagues from the marketing and sales and the legal departments of the company/organisation and not only R&D staff.
Characterisation of further KERs	The methodologies and the tools presented and exercised during the ESS should be applied to any other KER the Consortium will decide to exploit (individually and/or jointly).
Exploitation Plan-Planning	To finalise the Exploitation plan there is the need to organise common activities to collect and validate information and discuss next steps. It is recommended that the Coordinator/Exploitation Manager prepares a plan for such activities. Partners should, according to the plan, devote proper time to finalise the exploitation plan, integrating the needed information and developing the characterisation tables for each of the KERs.
Different type of organisations vs Exploitation	Exploitation can be commercial, societal, political, or for improving public knowledge and action and the utilisation of results in further research activities other than those covered by the action concerned, or in developing, creating and marketing a product or process, or in creating and providing a service, or in standardisation activities, etc... Project partners can exploit results themselves or facilitate exploitation by others (e.g. through making results available under open licenses). This clearly means that any type of organisation (private, public, for-profit, not-for-profit, etc) can exploit, it is not an activity reserved to for-profit type of organisations.
Discussing Exploitation at every Consortium Meeting	At every Consortium meeting there should be a dedicated session to discuss practical and strategical aspects of exploitation like it happened during the ESS and update KERs characterisation and risks analysis. The project should perceive the Exploitation Plan as a living document and: Update the plan according to the progress and emerging results of the project Consider changes in the stakeholders, work context and potential use of results during the project lifetime Report on the updates periodically

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Use of Key Performance Indicators (KPIs)	Please bear always in mind that KPIs have a specific role and are a measure of your performance against key objectives, and they should not be used as drivers for your actions. A timeline to achieve and measure KPIs should be added.
Plan for the Exploitation and Dissemination of Results (PEDR) – additional elements	When working on the Exploitation (and Dissemination) Plans, please: Keep the plan flexible enough and in line with the technological, economic, environmental, societal and legal context in which the project has been set up; Use the lean canvas approach to better define early adopters, current solutions, unique value proposition and commercialisation channels; Include enough quantitative and qualitative KPIs and milestones to facilitate the monitoring of is implementation; Show the link between the selected route to market, the proposed exploitation actions and the expected impact of the project; Highlight the value chain dimension of the project and make sure this is considered to find the best set up in terms of future collaboration as partnership and as individual entities.
Internal use of KERs	The opportunity to use internally the solutions developed, to create a suite of innovative solutions to be offered on the market, could be an advantage for the partners involved. Anyway, it is recommended to clearly state from the very beginning how this is going to happen and to craft a suitable strategy, highlighting the competitive advantage that partners will gain over competitors.
Monitoring risks	The barriers and risks for exploitation (actual use of the results after project funding) must be recognised and countered with appropriate measures. The service allowed participating partners to discuss exploitation risks and practice on how to assess them.
Customer Validation	Customer validation phase is important because you find out whether your assumptions regarding customers are true or false. Customer validation is about making sure that your research is correct and developing your business model to reflect that information. Essentially, if you can validate your customer related assumptions then you have potentially found customers who will buy your solution. Please refer as well to the set of slides provided annexed to this report.
IP ownership and collaboration for exploitation	It is strongly suggested that joint owners of KERs agree amongst themselves as soon as possible upon the detailed terms of exercising ownership and protection of such result in accordance and in proportion with the agreed intellectual contribution to its development. It is therefore wise to deepen more on the key exploitable results to fully investigate their potentials and partners' expectations. Considering the efforts invested over time in human resources and in developing the technical side of the solutions, it is understandable that the organisations involved in the development expect a return (increasing the distinctive skill set of the organization/consortium or improving internal processes or via sales or royalties on intellectual property rights). Bilateral or multilateral memorandum of understanding could be signed among relevant partners.

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