Annex II

Project work plan with tasks and responsibilities of each Party

The following information is copied from the project application:

1.7 Project activities

Workpackages / Activities	Description	Start date – End date	Cost
1 - Communication and dissemination	Dissemination and analysis of the project results. This WP is executed through physical and online meetings with the project partners and the participating companies and the results are reported by publishing journal and conference articles. Conference articles will be presented at the most prestigious conferences within and outside of Europe. A website will also be launched for presenting the results to general public. UiT is the responsible partner for this WP.	12/31/22 - 12/30/25	81,240

Workpackages / Activities	Description	Start date – End date	Cost
1.1 - Meetings	Control group meetings will be held twice a year to present a summary of project activities, evaluate the costs, and adjust the project plans. Technical meetings will be arranged with research organizations and companies when required; they range from one-to-one meetings to brainstorming sessions with multiple participants. UOULU is the responsible partner for this activity.	-	20,310
1.2 - Journal articles	This activity includes practical experiments, results analysis, and reporting the major findings for publishing in international journals. The working hours and costs needed for publishing articles comprise the major costs. UOULU is the responsible partner for this activity.	-	24,372
1.3 - Conference articles	This activity includes results analysis and reporting other findings for presentation in international conferences. The activity costs includes the conference and traveling fees. The 1st author of the manuscript will be the presenter of the article at the conference and the only one who travels. UOULU is the responsible partner for this activity.	-	36,558
2 - Project management and control	he project will be managed by project managers and the coordinator. The control group supervises the project and adjusts the direction of the project during control group meetings. The control group also evaluates the progress and achievements of the project after each meeting and in specified milestones. UOULU is the responsible partner of this WP. The project manager will plan meetings and follow-ups so that the necessary information moves between partners and that everyone has sufficient access to information to successfully carry out the project activities.	12/31/22 - 12/30/25	81,240
2.1 - Coordination	The control group organizes and	-	32,496

Workpackages / Activities	Description	Start date – End date	Cost
	leads the project managers to meet the requirements of the submitted application. The project coordinators are responsible for the scientific activities in the project, the quality of reports, and undertaking the publishing activities. UOULU is the responsible partner for this activity.		
2.2 - Project management and control	Project managers are responsible for their own project shares including budgeting, timing, research, and communication. Each partner have defined responsibilities that should be fulfilled in accordance with the overall objectives. UOULU is the responsible partner for this activity.	-	48,744
3 - Technology for DED processing	Surveys and analyzes of the major practical scenarios will be conducted together with the equipment and software providers to prepare the DED technology for commercial use. This consists of modernizing the methods and engineering processes by considering the following alternatives: (1) updating the existing welding/cutting cells for partial- and/or full-time 3D printing use; (2) investing in equipment upgrades. The aim is to accelerate the industry-scale adoption of DED technologies and to increase production value while minimizing the investment costs and the manufacturing quality is maintained or improved. UOULU is the responsible partner for this WP. During the implementation of this WP, regular MS-Teams meetings will be held at least once a month, where the progress of the work is monitored. Communication will also include dissemination of the information on how to transform MIG/MAG cells, laser cells, robots, and CNC cells into DED, as well as commercial and technical possibilities of this	12/31/22 - 6/29/24	385,889

Workpackages / Activities	Description	Start date – End date	Cost
	transformation. These results will be published along with information on DED-based production systems, their costs, advantages, and disadvantages.		
3.1 - Transformation of the existing welding and cutting cells into DED	In commercial production, there are many welding and cutting cells that do not run at full capacity. To address this issue, this activity focuses on determining the possibilities of transforming either MIG/MAG or laser cells into DED by investing in printing heads and control technologies and software. This activity will also explore the technical and commercial advantages and challenges of this transformation. UOULU is the responsible partner for this activity. The outcome of this activity provides information on how to convert the existing welding or laser cells to DED; industrial organizations are the target audience to increase knowledge of the technical and commercial advantages of the transformation to DED. The major findings of this WP will be shared with the international audience using scientific and/or non-scientific publications.	-	154,355
3.2 - Transformation of the existing robot and CNC cells into DED	Robots and CNC cells are generally more expensive than DED equipment. In case of having low production capacity or the need for general equipment modernization, these units can be transformed into AM with relatively low cost. This activity explores the possibilities for such solutions to provide guidelines for a smooth DED adoption. UOULU is the responsible partner for this activity. As a major outcome of this activity, companies will receive guidelines on how to utilize the existing robots and CNC cells with low capacity utilization rates in DED transformation.	-	115,767
3.3 - System structure for DED	DED technology has seen rapid development in the past few years; novel solutions have been introduced for both industry and research use. This activity	-	115,767

Workpackages / Activities	Description	Start date – End date	Cost
	explores various configurations of DED-based production systems, their costs, advantages, and disadvantages. The results will be summarized and compared considering the outcomes of the previous activities. LTU is the responsible partner for this activity.		
4 - Laboratory scale DED processing	This WP consists of performing laboratory-scale experiments to generate the necessary know-how and practical guidelines for DED adoption. The state-of-the-art technologies will be used for performing the experiments. The possible future developments will also be considered through simulations. Every activity under this WP includes production trials to measure the mechanical material properties of DED metals, possibilities to produce various forms with large geometries, as well as the competitiveness analysis (i.e., material performance, manufacturing time and flexibility, investment costs, etc.). LTU is the responsible partner for this WP. During the implementation of the work package, regular monthly meetings will be held to monitor the latest progress. The results of laboratory-scale experiments will be published as conference and journal papers.	12/31/22 - 9/29/25	751,469
4.1 - WAAM experiments	This activity focuses on executing Wire Arc Additive Manufacturing WAAM, which is the most basic DED process. WAAM experiments will be performed with a commercial MIG/MAG welding source at UOULU using both conventional steel and UHS. The experiments will be focused on building demanding geometries, such as convexo-concave shapes and lightweight panel structures. The material properties, especially fatigue resistance will be measured and compared with those of traditional	-	300,587

Workpackages / Activities	Description	Start date – End date	Cost
	manufacturing-based parts/products. UOULU is the responsible partner for this activity. A minimum of three scientific conference papers and/or journal papers will be published to share the major findings of this activity. Nonscientific reports/articles may also be considered when required.		
4.2 - Laser DED experiments	As a more sophisticated DED technology, the commercial laser DED uses a laser beam as the energy source and either wire or powder as a feedstock material. These items can be combined in different ways. How the robot moves during DED is determined by the equipment type, setups, software, and build strategies. Despite the availability of laser DED processing machines, the control software is in the early stages of development with simple geometries and control leverage. This activity improves the laser DED processes and develops test models and material characterization to address the process limitations. Finally, the process mechanisms and means to improve manufacturing quality and process stability will be explored. LUT is the responsible partner for this activity. Guideline for the best laser DED processing practices, test models and stable processing will be the major outcomes of this activity. Manufactured test models will be shared with the participating project members and other interested organizations. Scientific reports will be provided to share the major findings with international researchers.	-	225,441
4.3 - Laser DED multi-material process development	Functionally graded materials are of great interest in many industries, but require complex processing. In a preliminary study, a new technique based on laser beams and metal wire is tested for enabling the production of such components. In this method, a series of (contact-free) droplets	-	225,441

Workpackages / Activities	Description	Start date – End date	Cost
	are used with movements that form a built track. With the single-drop generation of droplets, this method allows for an in-between shift of feeding material, which enables the production of multi-material structures. New equipment and control systems are required in addition to the CAD/CAM preparation when building components. This activity begins with studying the frequency of droplet generation and the accuracy of placement has been studied. It will then focus on manufacturing the feeding system and developing the control software to enable more precise controlling of wire feeding, laser power synchronization and shifting of materials. Finally, similar materials will be utilized to investigate the material properties and morphology of built structures. LTU is the partner responsible of this activity. The outcome of this activity includes a platform with a demonstration and control unit enabling multi-material laser DED processing.		
5 - DED demonstrations for various applications	The outputs of WP3 and WP4 provide a holistic demonstration of the optimized DED processing for general use cases. In this WP, three cases with different features are selected to set the foundation for new application areas at the commercial level. Each application field will be explored scientifically in a separate activity. LTU is the responsible partner for this WP. During the implementation of the work package, regular MS-Teams meetings are to be held, at least once a month, to check the WP progress. The results of the research carried out in the WP will be directly disseminated to companies in the region.	6/30/24 - 12/30/25	487,439
5.1 - Repair of broken steel products	DED processes are already in commercial use in Sweden, where railway companies utilize simple DED for the maintenance of heavy	-	121,860

Workpackages / Activities	Description	Start date – End date	Cost
	steel components. Extending the knowledge on the optimization of material properties and manufacturing technology, the know-how of bringing such operations to the Northern parts of Scandinavia is the main of this activity. Activity 1 includes empirical WAAM trials of broken components for addressing this typical need of the regional industry. The performance of the manufactured components will be analyzed using empirical testing. UOULU is the responsible partner for this activity. This activity provides information on how metal parts can be repaired with the DED process; the outcomes will be published in forms of conference papers and technical reports.		
5.2 - Replacement of casting in manufacturing of iron-based components	Welding inserts and other cast parts are challenging both from manufacturing flexibility and material performance perspectives. As a flexible process, DED enables the manufacturing of custom-built components for individual applications; this is contrary to casting, which is typically used for mass production. Besides, there is an ongoing discussion on whether the lifetime (fatigue strength) of the DED components is better than that of cast parts; the WP4 will either confirm or refute the improvement in fatigue strength. Finally, component-scale fatigue tests will be performed for validating the results. LTU is the responsible partner for this activity. The outcome is new information about the mechanical properties and fatigue strength of parts made with the DED process. The results are published in conference and journal papers and technical reports.	-	170,604
5.3 - Demonstrator development of multi-material processing with laser DED	As a continuation of WP4 A3, this activity develops CAD/CAM software and extends the possible range of materials for DED. Extensive process tuning is	-	194,975

Workpackages / Activities	Description	Start date – End date	Cost
	expected before real samples are manufactured. Demonstrator test cases will then be identified, made, and analyzed to provide detailed insights. Finally, tests similar to WP5 A1+A2 will be conducted to compare the multi-material component properties with uni-material counterparts in terms of mechanical properties. LTU is the responsible partner for this activity. The outcomes of this activity include CAD/CAM software for building components using the new multi-material laser DED process. Besides, scientific reports on processing conditions, building structures using the new method, and material properties will be provided.		
6 - Logistical supports for DED AM	The AM adoption benefits are twofold. The first set of benefits comes from the product impact, which is mostly about the technical features of the parts/components specified in the engineering/design phase. This is the focus of the earlier WPs. The second advantage relates to the supply chain impact. Considering the harsh climate and remote conditions in the Nordic region, there is a need to understand the underpinnings of the logistical changes pertinent to the AM adoption in the steel industry. This will not only facilitate the know-how of the planning activities but also help take full advantage of AM adoption in the sector. Besides, the AM-based adoption in the steel production industry in the Nordic region have implications for exploiting the logistical properties of additively produced parts/components in infrastructure projects (i.e., transportation of large size products and those with complex installation requirements) and for more effective maintenance operations in remote areas. The following activities are defined to address the above-mentioned topics.	12/31/22 - 12/30/24	243,720

Workpackages / Activities	Description	Start date – End date	Cost
	UiT is responsible for this WP. UiT will hold regular online meetings with the rest of the partners once every month to communicate the progress and exchange ideas. The WP outcomes will be disseminated to the regional companies and academic publications will report the major findings to international readers.		
6.1 - Supply chain mapping of the steel industry	This activity begins with identifying the supply chain players in the region and the customers worldwide and modeling the value chain. This provides information about where the products or services are coming from, how the operations are done, and who is responsible for different operations. This information is essential for cost and risk analysis, among other supply chain performance indicators that will be used for benchmarking in the last activity. UiT is the responsible partner for this activity. A report will be submitted at the end of this activity.	-	97,488
6.2 - Transformation of the logistical elements	This activity analyzes the changes that should be made on procurement, facility planning, inventory management, and transportation operations for transformation from traditional manufacturing to DED. The possible changes are industry- and case-specific; such analysis will provide insights for decisions regarding AM adoption by other regional companies. UiT is the responsible partner for this activity. The results will be reported in a conference paper or book chapter.	-	73,116
6.3 - Modeling and quantification of the value added	To model, quantify, and compare the value-added of using DED in steel production compared to the current norms where the traditional production means are applied. Besides, decisions in the tactical and operational levels will be explored. This activity continues by developing	-	73,116

Workpackages / Activities	Description	Start date – End date	Cost
	simulation/optimization and decision-making models. A journal article will report the outcomes of this activity. UiT is the responsible partner for this activity.		

1.8 Indicators

Applications submitted to EU programmes	Comments: At least four applications will be submitted, one per part and one common. The intention is to submit international EU applications, but the national-level calls may also be considered if they are perceived to be more suitable. All applications will be closely related to the aim of the project IDiD, both in terms of collaborations and technical objectives. These applications will all be considered as extensions or continuations of the activities and collaboration within the IDiD platform. The target calls and the project idea are listed below. HORIZON-CL4-2023-TWIN TRANSITION-01:02. This application will be formed around hollow-section profiles and lattice structures by additive manufacturing and automatic simulation tools. The conventional and/or new products would be designed using smart simulation and design programs so that the empirically validated structural details can be transferred to the products considering its requirements. HORIZON-CL4-2023-TWIN TRANSITION-01:03. This application is about utilizing additive manufacturing (PBF or DeD) for producing custom-built products cost-effectively. The outcome of WP5 Activity 2 will offer promising solutions for this call, especially becaise casting is not a custom-built process. Besides, cost-effectiveness can be improved for demanding applications by enhancing the material properties of DED. HORIZON-CL4-2023-TWIN TRANSITION-01:04. This is the main targeted call for the further development of DED. The project idea mainly relates to WP5 - Activity 1, which is to utilize DED for repairing broken components and/or to use scrap metals as feedstock material. In addition, WP4 outcomes will be used for developing the necessary skills and to educate remanufacturers such that	4 Applications

	the material quality can be optimized for different use cases.	
Research organisations participating in joint research projects	The main motivation for the IDiD consortium is to bring together the equipment and expertise of the partners and strengthen the impact of the project and future EU cooperations. These equipments are mostly required for conducting DED manufacturing experiments (i.e., laser DeD) and material characterization (e.g. micro CT-scanning, nano-indentation, Atom Probe Tomography and ultrasonic fatigue testing). In addition to the main consortium of FMT (UOULU), LTU, LUT, and UiT, a handful of other research organizations will be included in the project. The preliminary discussions are being undertaken for including Umeå University (Sweden), RISE institute in Piteå (Sweden), Fraunhofer IWS (Germany), Research center of Juelich (Germany), Aachen RWTH (Germany), BOKU Vienna (Austria), Tennessee Tech. (USA), Egypt Japan University Of Science and Technology (Egypt), Università Politecnica delle Marche (Italy), SINTEF (Norway), Centek (Finland), Rovaniemi University (Finland), VTT (Finland), and the University of Turku (Finland).	14 Research organisations
Enterprises cooperating with research organisations	Comments: In addition to the companies already included in the consortium, the following corporations will join in the later stages of the project. Preliminary contact has already been established with the following list of enterprises for possible cooperation in IDiD. From Sweden: Procada, LMI, Duroc, Ditwin, Sandvik, ESAB, Husqvarna, Normada Furniture, Svalson, Fumex, Indexator, Conex, AMEXCI, Räddningstjänsten Skellefteå, Scania, Mekinor, Gestamp Hardtech. From Norway: Maritime Tech Cluster/KUPA; And from Finland: Randax, Nokia Solutions, Ponsse and Networks Oy, Mecaplan, Miilux, Skoda, 3D step, Emprofe, SSAB. Moreover, international equipment and software manufacturers are supporting the project through free consultations, sample manufacturing, etc; the Companies with signed LOIs are WAAM3D, Dotx Control, Meltio, Insstek, and Mx3D. The cooperating enterprises are from a wide range of industries, from equipment manufacturers to the designers and producers of the final products and the final customers	20 Enterprises

	buying the products. This cooperation strengthens the RDI activities, e.g., by offering the latest information on available technologies, free test specimens for empirical testing, and a wide network for disseminating the project results. Triggering discussion between the enterprises helps develop RDI on commercially interestig solutions and needs. Finally, these enterprises will form a strong basis for our future EU proposals.	
Jointly developed solutions	The following solutions are carried out in different stages of the project; Two solutions for enabling the conversion of the existing welding (1) /cutting (1) cells to work as DED equipment. Two solutions for converting the existing robot (1) /CNC (1) cells to work as DED equipment. Two solutions for building convex-concave-shaped structures (1) and a new lightweight panel structure (1) using DED. Novel solutions for test models (1) and material characterization (1) of products produced by DED. Solutions for improving manufacturing quality (1) and process stability (1) of DED. This set of solutions includes quality management, assurance, as well as process monitoring considering both real-time and post-analysis (e.g., NDT and DT). Four solutions for DED multi-material processing, including manufacturing of the feeding system (1), control software development (1), laser power synchronization (1) and shifting of materials (1). One solution for the repair of broken steel parts (1) using WAAM technology. One solution for replacement of casting in manufacturing of iron-based components (1).	15 Solutions
Number of approved applications to EU programmes	We expect to have 1 or 2 of our submitted applications approved; if so, these projects will be funded by Interreg Aurora and Horizon Europe.	2 Applications
Small and medium-size enterprises (SMEs) introducing product or process innovation	SMEs are expected to transform their existing welding and cutting cells into DED. Besides, they may introduce innovative solutions pertinent to repairing steel products with DED and	3 Enterprises

	replace cast steel products with DED products.	
Solutions taken up or up-scaled by organisations	From the jointly developed solutions, five are expected to be taken up for putting into practice. This will be presented as use case demonstrators and/or will be up-scaled by the participating organizations.	5 Solutions