PROJECT DELIVERABLE REPORT

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Joint Industrial Data Exchange Pipeline

Type: Deliverable Report

D5.2 Use Case 1 Incremental Demonstration

Issuing partner	TPI Composites (TPI)
Participating partners	TPI Composites (TPI), Zorlu Enerji Elektrik Uretim As (ZOREN), Adscensus (ADS)
Document name and revision	D5.2 v.01
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Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission services)	✓
CO	Confidential, only for members of the consortium (including the Commission services)	
SEN	Sensitive, limited under the conditions of the Grant Agreement	

Contents

Executive summary

This document presents the progress report for the Use-Case-1 demonstration of the JIDEP project. The demonstration is conducted in accordance with the **D5.1** - Use Case Demonstration Plan, and readers are encouraged to familiarize themselves with this plan.

This report serves as a resource for showcasing how a product or system effectively addresses real-world challenges. Its primary purpose is to illustrate specific scenarios in which end users interact with the system, thereby providing a clear understanding of its practical applications.

JIDEP demonstrations, including the Use-Case-1 demonstration, are designed to capture and mitigate all potential issues related to JIDEP, such as the graphical interface, accessibility, performance, data credibility, and ease of use. These requirements are pre-defined in the **D2.1** - Initial Requirements Specification Document. Consequently, this document reflects the current status of the JIDEP project from the end-user's perspective.

Finally, this report highlights the scientific achievements of the underlying R&D work aimed at chemically recycling end-of-life wind turbine blades.

It should be noted that the UC1 demonstrations began one year before the official demonstration started. This was needed to mitigate the R&D risks related to recycling. Instead of kick-starting the work on large wind-turbine blade samples, ZOR, TPI and ADS have decided to begin experimenting with smaller samples, thus greatly de-risking the chemical recycling challenges.

1 Use-Case-1 demonstration plan

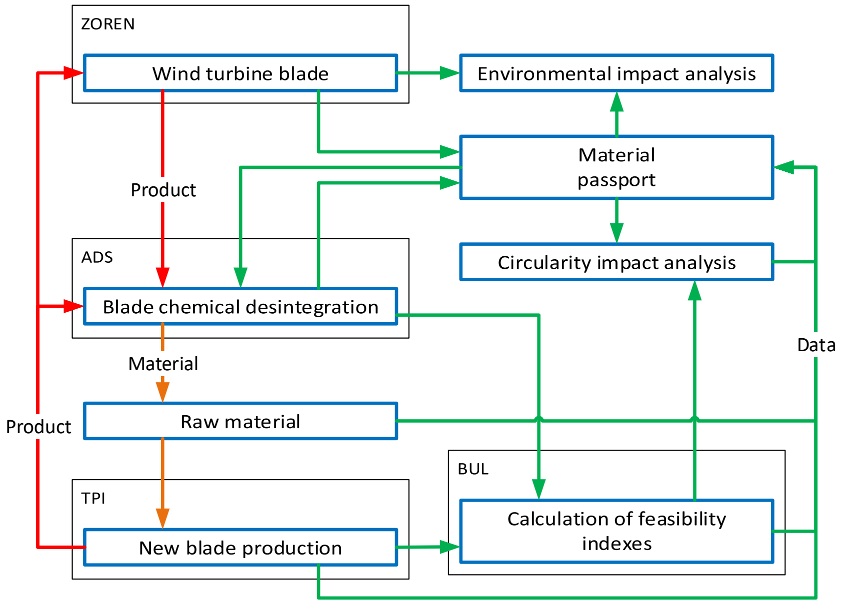

Figure 1: UC1 demonstration plan

The overall UC1 demonstration plan (**Error! Reference source not found.**) anticipates industrial cooperation between LEs, SMEs and Academia by placing JIDEP at the core of this collaboration.

The plan, as sown in the following table, distinguishes 7 activities, of which 4 activities have already been completed, and the remaining 3 are currently ongoing.

Step	**Demonstration activity**	**Planned start date**	**Actual start date**	**Status**
1	Extraction of wind turbine blade composite fragment (the fragment) (ZOREN)	2024 05	2024-04	Completed
	 The blades were cut from EOL wind turbine blade in Turkey. Blade product passport was created in JIDEP.			
2	Chemical disintegration of the fragment (ADS)	2024 06	2024 08	Completed

	 Glass fiber was recovered from the wind turbine fragment. Recycled fiber material passport was created in JIDEP.			
3	Re-fabrication of a new composite fragment using recycled fibers (TPI);	2024 07	2024 09	Completed
	 Recycled glass was re-used in thermoset composite plate fabrication thus proving that it is fit for a 2nd use.			
4	Fabrication of a new composite fragment using thermoplastic bonding (TPI);	2024 08	2024 10	Completed
	 New composite was made from a new glass fiber (left) and from recycled glass fiber(right) using thermoplastic bonding. The process is very complex and new, involves lots of trial and error, hence its definition begins in November 2024 and will continue until the end of the year.			
5	Efficient disintegration of a new, known-structure fragment (ADS);	2024 09	2024 09	Completed

	 The recycled glass fiber thermoplastic plate was successfully delaminated and glass fiber cloth recycled for the 2nd time. Complete circularity achieved. The thermoplastic composite recycling is simple, and it will be documented until the end of the year.			
6	Calculation of feasibility indexes (BUL)	2024 10	2024 10	Ongoing
	Feasibility index definition was confirmed and calculation methodology approved during consortium's November 5th plenary session.			
7	Environmental impact analysis (ZOREN)	2024 11	2024 11	Ongoing
	Environmental impact analysis methodology was confirmed during consortium's November 5th plenary session.			

2 Use-Case-1 demonstration results

2.1 Wind Turbine Blade Fragment Extraction (ZOR)

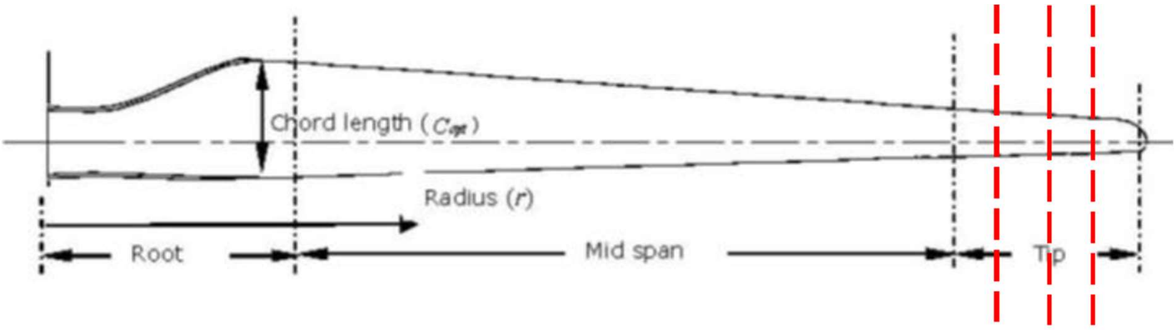

Figure 2: Blaed cutting scheme

Figure 3: Blade cutting process

The wind turbine blade extraction was performed in Turkey. Four large 1m^2 samples were cut (**Error! Reference source not found.**) from the EOL blade tip section. The selected zones were from the most flat section of the blade, as requested by ADS.

The blades were cut (**Error! Reference source not found.**) with a 4.5 kW Makita brand EK8100WS Gasoline Concrete Cutting Saw.

The gasoline saw with a 1.1 liter tank used 3 tanks during the blade-cutting process. A total of 3.1 liters of gasoline was used.

In addition, 0.2L of 2-stroke engine oil was used.

The working time of the saw with full performance and full throttle cutting was around 23 minutes.

The weight of each blade was around 25kg.

2.2 Chemical disintegration of the wind turbine blade fragment (ADS)

Methodology

Since October 2023 ADS ran a series of experiments leveraging Peracetic Acid (PAA) for breaking epoxy compounds. PAA is particularly effective at breaking down epoxy compared to other acids due to its strong oxidative properties, which can disrupt the chemical structure of epoxy resins. Although there were no earlier attempts to exploit PAA for recycling glass fibers, there are a few references to the decomposition of carbon fibers with PAA solvents, i.e.:

- “An Efficient Method of Recycling of CFRP Waste Using Peracetic Acid”, Mohan Das, Rinu Chacko, and Susy Varughese, ACS Sustainable Chemistry & Engineering 2018 6 (2), 1564-1571, DOI: 10.1021/acssuschemeng.7b01456
- Zhao, X.; Zhang, T.; Zhou, Y.; Liu, D., Preparation of peracetic acid from hydrogen peroxide: Part I: Kinetics for peracetic acid synthesis and hydrolysis. Journal of Molecular Catalysis 246-252. A: Chemical 2007,271 (1–2), DOI: 10.1016/j.molcata.2007.03.012
- Park, W. R. R.; Blount, J., Oxidative Degradation of Epoxy Resin Coatings. Industrial & Engineering, Chemistry 1957,49 (11), 1897-1902. DOI: 10.1021/ie50575a039

Process summary

Peracetic acid (PAA) offers notable advantages over other acids when it comes to breaking down epoxy compounds due to its unique combination of oxidative power and mild acidity. Unlike strong mineral acids like hydrochloric or sulfuric acid, which primarily rely on protonation to break chemical bonds, PAA acts as a powerful oxidizing agent. This means it can target and degrade the stable carbon-hydrogen (C-H), carbon-carbon (C-C), and carbon-oxygen (C-O) bonds in epoxy resins more efficiently. These bonds form the backbone of the epoxy's cross-linked polymer structure, making the material resistant to simple acid attacks.

PAA's oxidation capability allows it to break down these strong bonds, leading to the degradation of the polymer network that defines epoxy resins. Additionally, PAA decomposes into acetic acid and hydrogen peroxide, both of which contribute to its efficacy. The acetic acid offers protonation, aiding in weakening the bonds, while hydrogen peroxide provides further oxidative action. This dual mechanism - combining acid hydrolysis and oxidation - makes PAA more effective than acids that lack these dual functionalities. Other acids, like hydrochloric or sulfuric, may be stronger in terms of immediate acidity and corrosiveness, but they lack the oxidative capabilities that PAA brings.

Moreover, PAA is relatively safer to use environmentally, as it breaks down into non-toxic byproducts like water and acetic acid, minimizing long-term environmental damage compared to stronger acids, which may persist and pose greater ecological hazards. Its smaller molecular size also allows deeper penetration into the epoxy's structure, making it more effective even on internal bonds of the resin.

In summary, PAA's combined roles as an oxidizer and a mild acid give it a distinct edge over traditional acids when it comes to breaking down the resilient structure of epoxy compounds, making it a superior choice for industrial and chemical processes involving epoxy degradation.

Stages of chemical decomposition

The Mixing H_2O_2 with pure acetic acid in equimolar concentrations leads to the formation of peracetic acid (PAA) which is a very strong oxidizing agent and is expected to break down the crosslinked epoxy matrix:

$CH_3COOH + H_2O_2 \rightleftharpoons CH_3CO_3H + H_2O$ (1)

The proposed reaction mechanism for the decomposition of the crosslinked epoxy matrix consists of 2 steps:

- **Step 1:** Generation of acyloxy and hydroxyl radicals:

O-O bond in peracetic acid (PAA) is unstable and decomposes PAA into acyloxy and

hydroxyl radicals:

$CH_3COOOH \rightarrow CH_3COO^{\bullet} + OH^{\bullet}$

The generated hydroxyl radical can further react with PAA itself:

$CH_3COOOH + OH^{\bullet} \rightarrow CH_3CO^{\bullet} + O_2 + H_2O$

$CHCOOOH + OH^{\bullet} \rightarrow CHCOOO^{\bullet} + HO$

Acyloxy radicals also undergo further decomposition,

$CH_3COO^{\bullet} \rightarrow {}^{\bullet}CH_3 + CO_2$

$2CH_3COO^{\bullet} \rightarrow 2\ {}^{\bullet}CH_3 + 2CO + O_2$

Methyl radical is unstable and reacts with oxygen to form weak peroxy radical.

${}^{\bullet}CH_3 + O_2 \rightarrow {}^{\bullet}CH_3OO$

Recombination of the free radicals regenerates the PAA

$CH_3COO^{\bullet} + OH^{\bullet} \rightarrow CH_3COOOH$

- **Step 2:** Reaction of the acyloxy radical with the crosslinked epoxy network:

The C–N bond is a weak bond compared to C-C bond and hence, the acyloxy and the hydroxyl radicals attack this bond leading to the breakup of crosslinks. Another reason for the C-N bond scission could be the competition between nitrogen, oxygen and the benzene ring in sharing the electrons due to their electronegative nature. This also makes the crosslink points weak and vulnerable.

- **Step 3:** Reaction of hydroxyl radical with crosslinked epoxy network.

Formation of phenols and phenolic derivatives as well as species with carbonyl groups takes place during the decomposition reaction. The products formed at this stage are a mixture of low and high-molecular-weight compounds.

Epoxy decomposition reactor

All reaction conditions were made to be the safest and most user-friendly as it was possible. The staff were using hazmat suits, high durability chemically resistant gloves and full-face gas/vapor resistant masks. The main reactor was electrically grounded and had a dedicated fuse system. Steel-based electric water pumps were pre-filled with water and used both for the inlet of the Glacial Acetic Acid as well as the outlet of the Peracetic Acid mixture.

The Schematic representation of the reactor is shown in **Error! Reference source not found.**. (a) - HDPE container with heated water; (b) - steel container with indirectly heated PAA; (c) - blade fragment; (d) – thermocouple; (e) - heating element; (f) - PAA inlet/outlet; (g) – gas/vapor venting.

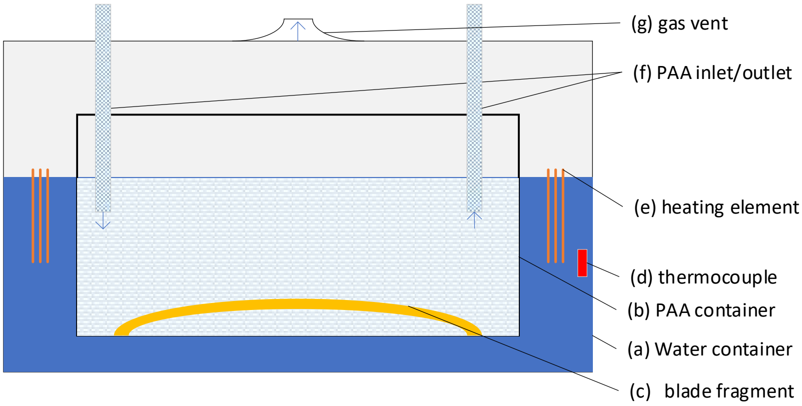

Figure 4: Epoxy decomposition reactor schematics

The wind turbine blade cut-out (c) is first washed with tap water and then placed in the steel container (b), wielded and mounted with heating elements (e). The steel container is placed inside an HDPE container (a), for safe and convenient heating - between two containers, tap water was added to ensure the stability of the heating process. That way, the heating elements could provide 1.5-4kW of heating power without direct contact with unstable PAA. The heating elements are connected to a thermo-regulating WiFi device (d) to ensure constant registration and observation of the temperature inside the reactor remotely.

Epoxy decomposition process

First, the preheating of the empty internal container (water) was made to around 35°C. The addition of the Hydrogen Peroxide was then done directly by pouring the canister of 25kg (50% purity) on the blade fragment. After that, Glacial Acetic acid (GAA, 99% purity) was introduced to the main steel reactor using 48L/min flow pumps at the inlet to the reactor (f). The amount of GAA used was ~190L, based on the visual observation of the drop in the volume of Glacial Acetic acid reservoir liquid level.

The reaction did not start at once as the created PAA was not set to the working temperature from the beginning. Also, the PAA reaction is endothermic by its nature, so the pre-heat, upon PAA creation, has dropped to ~25°C. Only when the water temperature in-between containers (a and b) has reached ~40°C, the reaction has become visible, and the bubbles from the sample (c) began to rise. This state was reached after 6 hours because the power to the 4 heaters was limited down to 4kW (total) to avoid gas cavitation and excess water vapor.

After 10 hours of constant heating, the reactor temperature reached 55°C – the set point of the thermo-regulating device. At this temperature the reaction speed has reached its maximum and the water has begun to vaporize more intensely. Due to this, condensation took place and the droplets of the condensed water vapor began to engulf the system. A short circuit has occurred and the knock out of the fuse took place. The event happened at around 20:00. The reaction had to be let go by itself as the temperature dropped and it was untouched until morning. Nevertheless, the specific heat capacity of the water buffer was enough to sustain the active reaction up until the morning, and even at 11:00, there was still a 30°C temperature within the reactor, and the reaction itself was visibly active.

After having observed the fully separated coating layer, it was concluded that the epoxy decomposition of the blade fragment was successful. The outlet pump was activated (f), to ensure safe redistribution of the reactant liquid to a waste container for further safe storage and disposal. The blade fragment became visible because the opaque PAA mixture with dissolved epoxy resins was pumped out.

Results

The wind turbine blade fragment with dimensions of 1m x 0.7m x 0.07m (the corner of 1m x 1m sample was cut off manually due to physical limitations of the container size), was successfully disintegrated using PAA solution in 35-55°C temperature range. The level of disintegration is assumed to be 30%-40%. It is likely, that 60%-80% disintegration could be reached during the 2nd reaction phase, but improvements to the heating element isolation must take place before. Also, welding sections of the steel container should be coated to prevent excessive corrosion on those segments.

Volumes and temperatures

- 25kg glass-fiber composite wind turbine blade fragment (1cm-2cm thickness).
- 190 L glacial acetic acid
- 20 L (25 kg) hydrogen peroxide
- 250 L tap water
- 25°C->55°C ->35°C reaction temperature cycle

Wind turbine blade decomposition – visual process reconstruction

Figure 5: The H_2O_2 is poured manually into the reaction chamber

Figure 6: The acetic acid is injected without human presence via a dedicated inlet

Figure 7: The reaction begins. ~250L of water is heated to 55C thus heating 215L of PAA to the same temperature. PAA and water vapor condenses on the reactor wall. Reaction bubbles emerge immediately upon contact with epoxy and coating surface

Figure 8: After 6 hours, the de-laminated coating (1st layer of the fragment) is visible on the surface of the reactor

Figure 9: After PAA is pumped out, the water is added to the reactor to remove the residual acetic acid and hydrogen peroxide. The 2nd layer of the fragment - glass fiber sheet – is visibly self-delaminated

Figure 10: NaOH is poured manually into the emptied reactor to neutralize residual PAA that is absorbed within the blade fragment

Figure 11: The exothermic reaction is causing a highly turbulent flow thus ensuring removal of residual epoxy compounds that might have remained on the glass fiber sheet

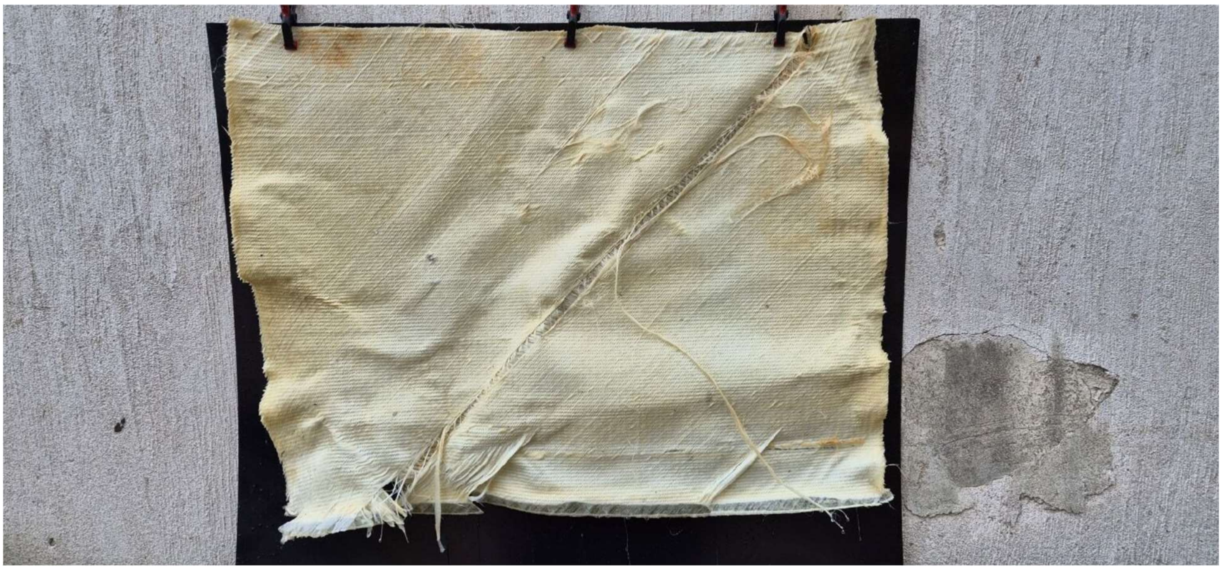

Figure 12: The 2nd layer (glass fiber sheet) is removed from the reactor and dried

Figure 13: Intermedia layers, including the glass fiber wool, are being dried and visible

Figure 14: The contaminated PAA is stored in a vented HDPE container, dissolved with water 4:1. Over time, it decomposes into its constituent products—acetic acid, hydrogen peroxide, and oxygen

3 JIDEP testing activities

3.1 JIDEP testing activities – ZOR

While project R&D work was ongoing, ZOR spent time on user acceptance testing providing valuable insights and remarks to the software development team on bugs and issues early versions of JIDEP were facing.

UAT Team & Hardware			
Company Name	**Tester Name**	**Operating System**	**Browser**
ZORLU ENERJİ ELEKTRİK ÜRETİM AŞ.	ZEYNEP KORKMAZ	Windows 10 Enterprise 22H2 10.08.2023 19045.4170 Windows Feature Experience Pack 1000.19054.1000.0	Google Chrome 127.0.6533.100 (64 bit)

UAT Scope (In Scope – Out of Scope)	
UAT - In Scope	**UAT - Out of Scope**
In Scope *List of features that will be tested* - **UAT1:** User registration - **UAT2:** User authentication - **UAT3:** Material passport creating for CFRP car beam in standard configuration. - **UAT4:** Material passport creating for CFRP car beam in "green" configuration starting from data of UAT3 - -**UAT5:** Search and view of "external" (from other users) Material passports in the platform - **UAT6:** Publication of Material passports in Marketplace	Out of Scope *List of features that will not be tested.* - **UAT7:** Remove of Material passports from Market place - **UAT8:** Modification of existing Material passport (CFRP car beam in "green" configuration) - **UAT9:** QR code view of material passport - **UAT10:** View of existing material passport data

UAT Assumptions
- **Test environment:** The test cases will be conducted in the manual-test.jidep.co platform. - **Test documentation:** All UAT test cases are documented in **UAT Requirements-Based Test Cases** table (page 2 – page 3) - **Test result report:** Success, Errors, failures and other will be reported in **UAT Test Results** table (page 3)

Figure 15: JIDEP UAT testing report by ZOR

3.2 JIDEP testing activities – TPI

TPI can confirm it was pro-actively engaged in the JIDEP user acceptance testing activities.

UAT Team & Hardware			
Company Name	**Tester Name**	**Operating System**	**Browser**
TPI COMPOSITES	UTKU TIRIC	Windows 11 Pro 23H2 Windows Feature Experience Pack 1000.22700.1020.0	Google Chrome

UAT Scope (In Scope – Out of Scope)	
UAT - In Scope	**UAT - Out of Scope**
In Scope *List of features that will be tested* - **UAT1:** User registration - **UAT2:** User authentication - **UAT3:** Material passport creating for CFRP car beam in standard configuration - **UAT4:** Material passport creating for CFRP car beam in "green" configuration starting from data of UAT3 - -**UAT5:** Search and view of "external" (from other users) Material passports in the platform - **UAT6:** Publication of Material passports in Market place - **UAT7:** Remove of Material passports from Market place - **UAT8:** Modification of existing Material passport (CFRP car beam in "green" configuration) - **UAT9:** QR code view of material passport - **UAT10:** View of existing material passport data	Out of Scope *List of features that will not be tested.*

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Figure 16: JIDEP UAT testing report by TPI

3.3 JIDEP testing activities – ADS

ADS was one of the early user acceptance testers. While no significant system bugs or malfunctions were identified, ADS raised certain issues related to the way product passports are being structured. E.g. certain new templates are needed to provide passports for raw materials, hence the template customization feature is very much welcome.

UAT Team & Hardware			
Company Name	**Tester Name**	**Operating System**	**Browser**
ADS	Kasparas Kižys (R&D Manager)	Win 11 Pro	Microsoft Edge for Business Version 127.0.2651.105

UAT Scope (In Scope – Out of Scope)	
UAT - In Scope	**UAT - Out of Scope**
In Scope *List of features that will be tested* - **UAT1:** User registration - **UAT3:** User authentication - **UAT4:** Functionality testing	Out of Scope *List of features that will not be tested.* - **UAT2:** Company registration

UAT Assumptions
- **Test environment:** The test cases will be conducted in the manual-test.jidep.co platform. - **Test documentation:** All UAT test cases are documented in **UAT Requirements-Based Test Cases** table (page 2 – page 8) - **Test result report:** Success, Errors, failures and other will be reported in **UAT Test Results** table (page 9 – page 10)

Figure 17: JIDEP UAT testing report by ADS

3.4 JIDEP validation activities - ZOR

ZOR ensured the visibility of EOL wind turbine blade samples has been made available within JIDEP.

Manufacturer

Name:	Zorlu Enerji Elektrik Uretim As
Registration Number:	199 34394
Registration Country:	Turkey

Suppliers

No suppliers are currently available.

PHYSICAL PROPERTIES

Dimensions:	98cm X 100cm X 7cm
Root Diameter:	N/A
Max Chord:	N/A
Max Laminate Thickness:	N/A
Mass:	25kg
Density:	N/A
Heat Transfer Coefficient:	N/A
Thermal Conductivity:	N/A

TURBINE BLADE PARTS

There are broken blades in pieces that are idle in our wind power plant.

1.00 €

− 1 + ADD TO CART

Terms and Conditions
30-day money-back guarantee
Shipping: 2-3 Business Days

Figure 18: JIDEP material passport validation by ZOR

ZOR can confirm the successful validation of LCA tool for the wind turbine blade fragment.

Life Cycle Assessment (LCA) Results

Evaluated Life Cycle Assessment (LCA) using the above Life Cycle Inventory (LCI) data

Characterisation

The substances that contribute to an impact category are multiplied by a characterisation factor that expresses the relative contribution of the substances for various environmental impact categories.

Reference: https://simapro.com/wp-content/uploads/2020/10/DatabaseManualMethods.pdf

Characterisation

Show 10 entries Search:

Indicator name	Amount	Unit name
Abiotic depletion	0.005235826886789685	kg Sb eq
Abiotic depletion (fossil fuels)	16370.820983026799	MJ
Acidification	4.021616244989998	kg SO2 eq
Eutrophication	1.191900370109858	kg PO4--- eq
Fresh water aquatic ecotox.	316.2609455999482	kg 1,4-DB eq
Global warming (GWP100a)	1096.1107978666503	kg CO2 eq
Human toxicity	790.3515828151231	kg 1,4-DB eq
Marine aquatic ecotoxicity	596558.9903532467	kg 1,4-DB eq
Ozone layer depletion (ODP)	0.00007541443326074513	kg CFC-11 eq
Photochemical oxidation	0.2918719197813947	kg C2H4 eq

Showing 1 to 10 of 11 entries Previous 1 2 Next

Figure 19: JIDEP LCA tool validation by ZOR

3.5 JIDEP validation activities – TPI

TPI leveraged the JIDEP product passport (PP) facility to announce the availability of EOL wind turbine blades for recycling. To populate all the necessary records, a real fabrication datasheet of the wind turbine was used. The entries of particular interest to ADS were the types of glass fabrics used, as well as epoxy and hardener formulae. Also, types of coating material were relevant. **Error! Reference source not found.** depicts the fragment of the wind turbine blade datasheet.

PRODUCT NAME	SPECIFICATION	DESCRIPTION	SUPPLIER	VENDOR PART #
1000 g/m² UD	A50WE005	LAYERED GLASS FABRIC 1000G/M2 UD	SAERTEX	U14EU920-00940-XXXXX-100000[1]
			OWENS CORNING	C-1000 SE1500
			OCV-US	C3000/1001/XXXX , C3000/1002/XXXX
			OCV-China (US Rovings)	EKU1000
			KUMPERS	HPT 970 E0
800 g/m² BIAX	A50WE007	LAYERED GLASS FABRIC 45 DEGREES 800 GM2 BIAX	SAERTEX	U32EX020-00830-XXXXX-264000[1]
			OWENS CORNING	DB-800 SE1500
			OCV-US	X2400/1013/XXXX
			OCV-China (US Rovings)	EKB830
			KUMPERS	HPT 830 E45 SF090
COATING	A50WE008	COATING SYSTEM FOR WIND TURBINE BLADES	RELIUS	OLDODUR BLADE PROTECT I372-7035 WINCOAT FINISH I394-7035 Wind HS Topcoat Main component I306-7135 Hardener I385-1306
			MANKIEWICZ	ALEXIT PRIMER 463-90 ALEXIT TOPCOAT 471-36 ALEXIT 405-73 Hardener ALEXIT 400 Hardener ALEXIT BR1275-BladeRep Topcoat 12 ALEXIT BR9075-BladeRep LEP 9
			Sherwin Williams-US	2.8 VOC Epoxy Primer E61AV2803 V93VY9 Epoxy Primer Hardener Polane F63AC177 Top Coat V66VC246 Top Coat Hardener
HLU RESIN	A50WE013	EPOXY HLU RESIN SYSTEM	MOMENTIVE	EPIKOTE MGS LR 135 Epikure Curing Agent MGS LH 1364 Epikure Curing Agent MGS LH 134 Epikure Curing Agent MGS LH 137
			SWANCOR - TIANJIN	Hand Layup Epoxy Resin 2513-A Hand Layup Epoxy Resin Fast Hardener 2513-BR Hand Layup Epoxy Resin Slow Hardener 2513-BL

Figure 20: EOL blade datasheet part

TPI also validated the product passport capability of the entire wind-turbine blade. For the 1st time, the company has created a live and working QR code granting access to the blade.

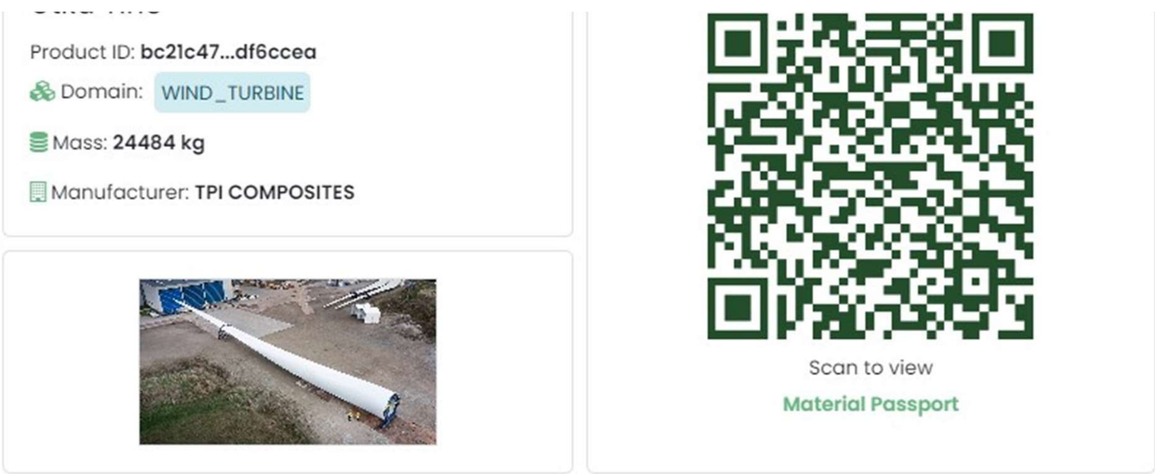


Figure 21: JIDEP material passport tool validation by TPI

The validation facilitated hypothetical values of the recycled material fractions because it is still impossible to precisely evaluate weather recycled glass fiber cab ne retrofitted into the new blade fabrication.

Data Authenticity

ID: **bc21c477-031a-458b-a0d9-3b54fdf6ccea**

Proof: **Verified with Blockchain**

Add to my list

Utku Tiric

Domain: WIND_TURBINE

Trade Name:	TPI COMPOSITES
Brand Name:	TPI COMPOSITES
GTIN:	N/A
EAN:	N/A

About this item

80 meter wind blade with epoxy resin

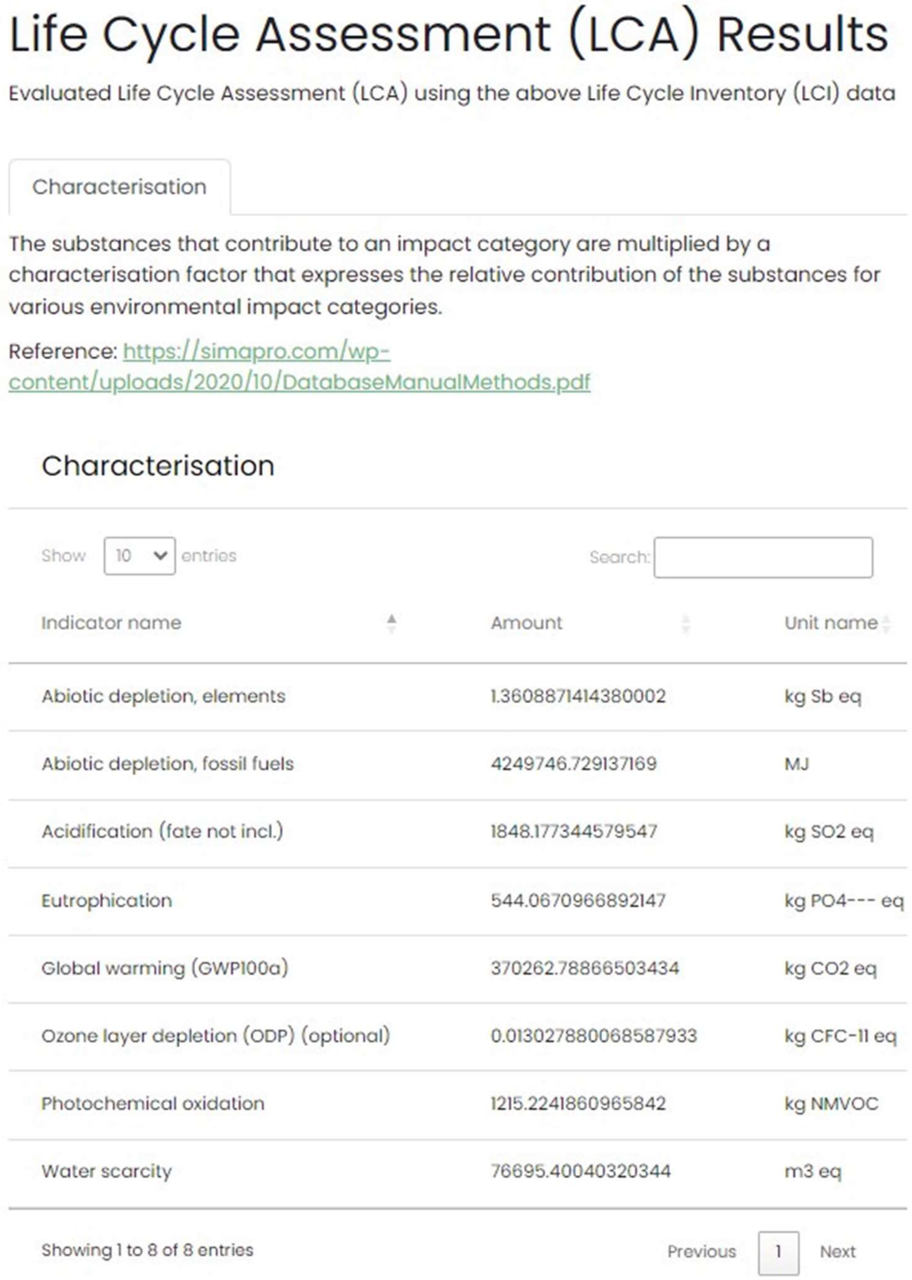
COMPOSITION PROPERTIES

Sub-assemblies

Sub-assembly Number	Material Name	Mass (kg)	Recycled Content (%)	Reused Content (%)	Recycle Collection (%)	Reuse Collection (%)	Recycling Efficiency (%)	Recycled Feedstock Efficiency (%)
L1S1	Balsa Core	688.9	0.00	0.00	50.00	0.00	50.00	50.00
L1S2	Pet Core	369.1	0.00	15.00	50.00	0.00	50.00	50.00
L1S3	Glass Fiber	11775	0.00	0.00	50.00	0.00	50.00	50.00
L1S4	Carbon Pultrusion	3759.3	0.00	0.00	50.00	0.00	50.00	50.00

Figure 22: JIDEP material composition validation by TPI

Finally, for the first time, TPI has performed the LCA calculation for the entire turbine blade. The functionality if confirmed, however, validating the results is a very complicated task due to hundreds of components that not only are constituents of the turbine blade, but also go into the production of the blade.



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Reference: https://simapro.com/wp-content/uploads/2020/10/DatabaseManualMethods.pdf

Characterisation

Show 10 entries Search:

Indicator name	Amount	Unit name
Abiotic depletion, elements	1.3608871414380002	kg Sb eq
Abiotic depletion, fossil fuels	4249746.729137169	MJ
Acidification (fate not incl.)	1848.177344579547	kg SO2 eq
Eutrophication	544.0670966892147	kg PO4--- eq
Global warming (GWP100a)	370262.78866503434	kg CO2 eq
Ozone layer depletion (ODP) (optional)	0.013027880068587933	kg CFC-11 eq
Photochemical oxidation	1215.2241860965842	kg NMVOC
Water scarcity	76695.40040320344	m3 eq

Showing 1 to 8 of 8 entries Previous 1 Next

Figure 23: JIDEP LCA tool validation by TPI

3.6 JIDEP validation activities – ADS

ADS has successfully recovered the glass fibers contained within the EOL wind turbine blade. The recovered materials were announced as new, recycled products, within the JIDEP material passport. The functionality is proven.

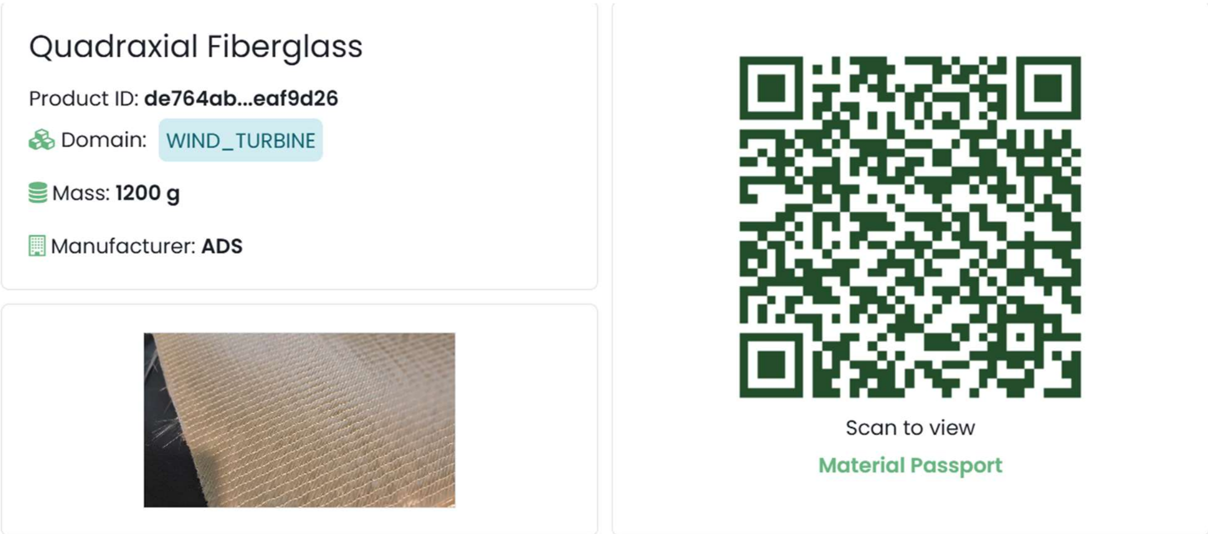
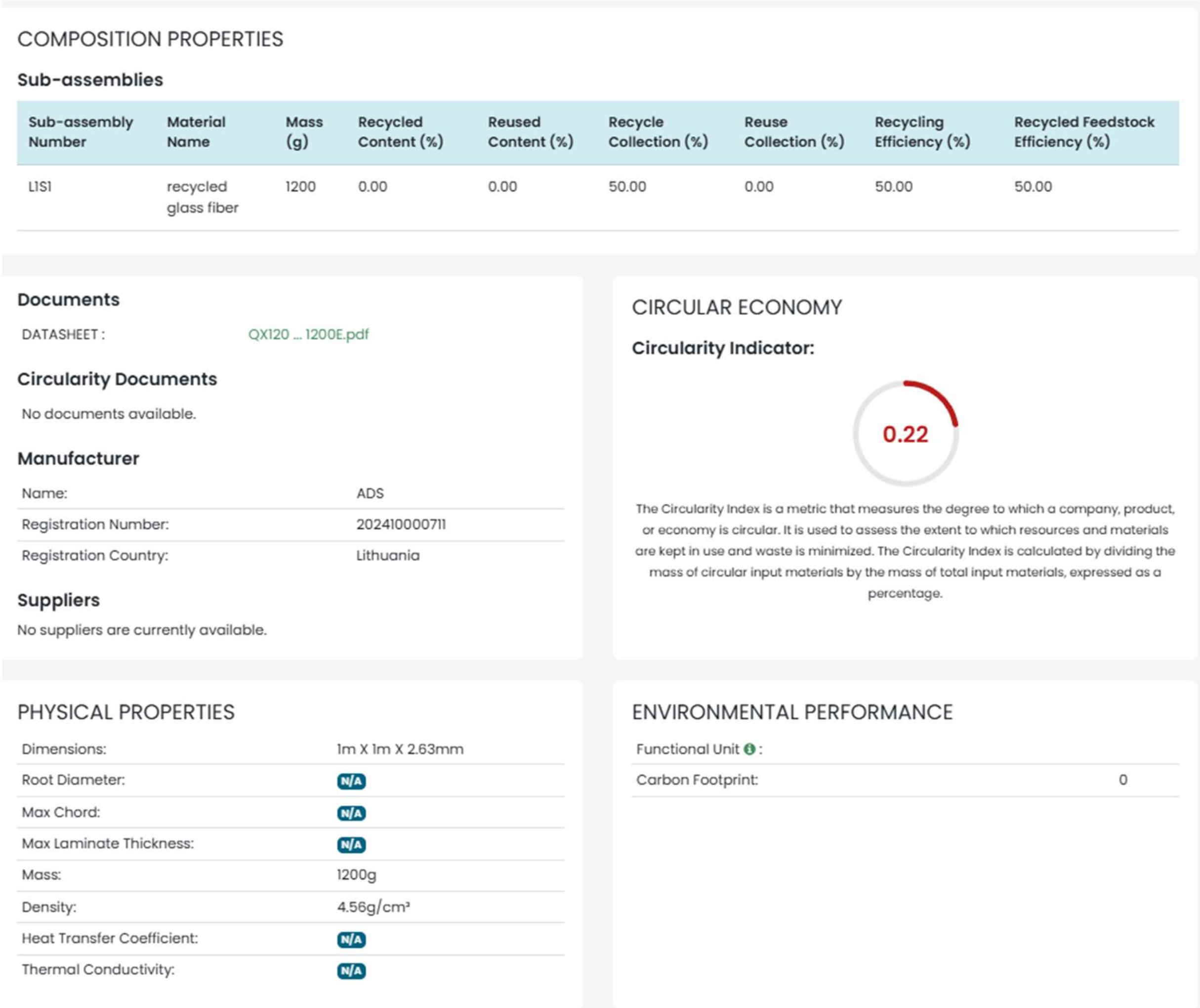


Figure 24: JIDEP material passport tool validation by ADS

The recycled material mass fractions entered are indicative because mass spectroscopy testing must be performed. The recycling efficiency cannot be confirmed until the waste cost analysis is performed – these tasks will be undertaken during the feasibility analysis part. Nevertheless, JIDEP functionality is proven.



COMPOSITION PROPERTIES

Sub-assemblies

Sub-assembly Number	Material Name	Mass (g)	Recycled Content (%)	Reused Content (%)	Recycle Collection (%)	Reuse Collection (%)	Recycling Efficiency (%)	Recycled Feedstock Efficiency (%)
L1S1	recycled glass fiber	1200	0.00	0.00	50.00	0.00	50.00	50.00

Documents

DATASHEET : QX120 ... 1200E.pdf

Circularity Documents

No documents available.

Manufacturer

Name:	ADS
Registration Number:	202410000711
Registration Country:	Lithuania

Suppliers

No suppliers are currently available.

CIRCULAR ECONOMY

Circularity Indicator:

0.22

The Circularity Index is a metric that measures the degree to which a company, product, or economy is circular. It is used to assess the extent to which resources and materials are kept in use and waste is minimized. The Circularity Index is calculated by dividing the mass of circular input materials by the mass of total input materials, expressed as a percentage.

PHYSICAL PROPERTIES

Dimensions:	1m X 1m X 2.63mm
Root Diameter:	N/A
Max Chord:	N/A
Max Laminate Thickness:	N/A
Mass:	1200g
Density:	4.56g/cm³
Heat Transfer Coefficient:	N/A
Thermal Conductivity:	N/A

ENVIRONMENTAL PERFORMANCE

Functional Unit :	
Carbon Footprint:	0

Figure 25: JIDEP product passport tool validation by ADS

ADS' recycling process is currently in the experimental state, therefore it was not certified. That prevents any LCA analysis of the recycling process and is estimated to require 2-3 years of further work, until recycling facility is complete, for such LCA testing to become feasible.

4 Conclusions and Next Actions

First, it should be noted that the work outlined in this report began one year ago. During the JIDEP TRENTO plenary session, ADS demonstrated small glass fiber fragments that had been chemically recycled, along with the early functionality of the JIDEP solution. It was a joint effort of 3 companies – ZOR, TPI and ADS.

The activities in this report build on the progress made a year ago and have since been upscaled. In addition to significant end-user testing of the JIDEP platform, numerous bug fixes, and feature rollouts, the laboratory-scale R&D activities have been scaled up to TRL6. This has led to new safety and logistics challenges, while also improving the accuracy of the data collected.

The primary cause of the slight delay in achieving Step-2 of the demonstration was related to the supply chain of chemicals and the safety regulations requiring proper permits to acquire, store, and process materials such as hydrogen peroxide. Ventilation issues were a significant concern. Additionally, the absence of sufficiently large HDPE containers capable of holding 1m² of wind turbine blade fragments required cutting 15% of the blade fragment to fit it into the reaction chamber. Certain chemicals were purchased in August 2024, and the summer vacation period affected the timeliness of deliveries from suppliers.

Upon receiving and examining the wind turbine blade fragments, it became clear that it would be impossible to refabricate identical samples of the same shape due to the high surface curvature (wind turbine blades are not flat). While JIDEP enables the collection of material passports via collaborative spaces, many critical documents (such as fiber layup schemes) were lost due to data retention policies exceeding the 10-year window. Furthermore, some types of glass fibers are no longer manufactured or are knitted using different patterns, making comparisons between recycled and new fibers challenging. Ongoing discussions with TPI are addressing Use-Case-1 demonstration activities - steps 3 and 4.In conclusion, the Use-Case-1 demonstration is still in progress. The R&D work conducted to facilitate JIDEP validation is proving valuable, and there will be numerous recommendations presented in Q4 2024 to improve the LCA tool, including enhancements to the circularity index estimation methodology.

To better distribute the workload among task leads within the WP5, the work package lead avoided unnecessary duplicate work that relates to the expansion of JIDEP's material database as well as excess fields within the material passport registration form. Both of these activities were thus covered by D5.3 task lead and thus can be skipped in this report.

This task has achieved significant milestones. It has, for the first time, demonstrated the capability to disintegrate EOL wind turbine blades composites. Also, it has, for the first time demonstrated the capability to re-use the recycled glass fibers in classical thermoset composites. Furthermore, it has, for the first time, tested the inclusion of recycled glass fibers in novel thermoplastic compounds by also showcasing the opening of a 2nd circularity loop.