Renewable Parts Ltd

Recirculated Parts
A circular economy for the wind industry

Carol Sheath
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Renewable
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Company Intro

Our vision

The wind industry is a green energy source, but the aftermarket remains largely non-green

Linear procurement practices remain deeply ingrained for minor parts

The opportunity to embed greater sustainability within the aftermarket has substantial benefits

But this requires a complete change of culture and a willingness to invest in circular economy technology

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What we do

Parts supply & inventory management - to minimise lead time and maximise turbine availability

Development and production of recirculated products – refurbishment, remanufacture, reuse and redesign of parts to provide a more sustainable alternative to new

136,000
Items travel through our supply chain annually

125t
Of material diverted away from landfill and scrap

365tco²eq
Of carbon emissions reduced since 2019

2600+
Turbines are currently supported across our global supply chain

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Where we are

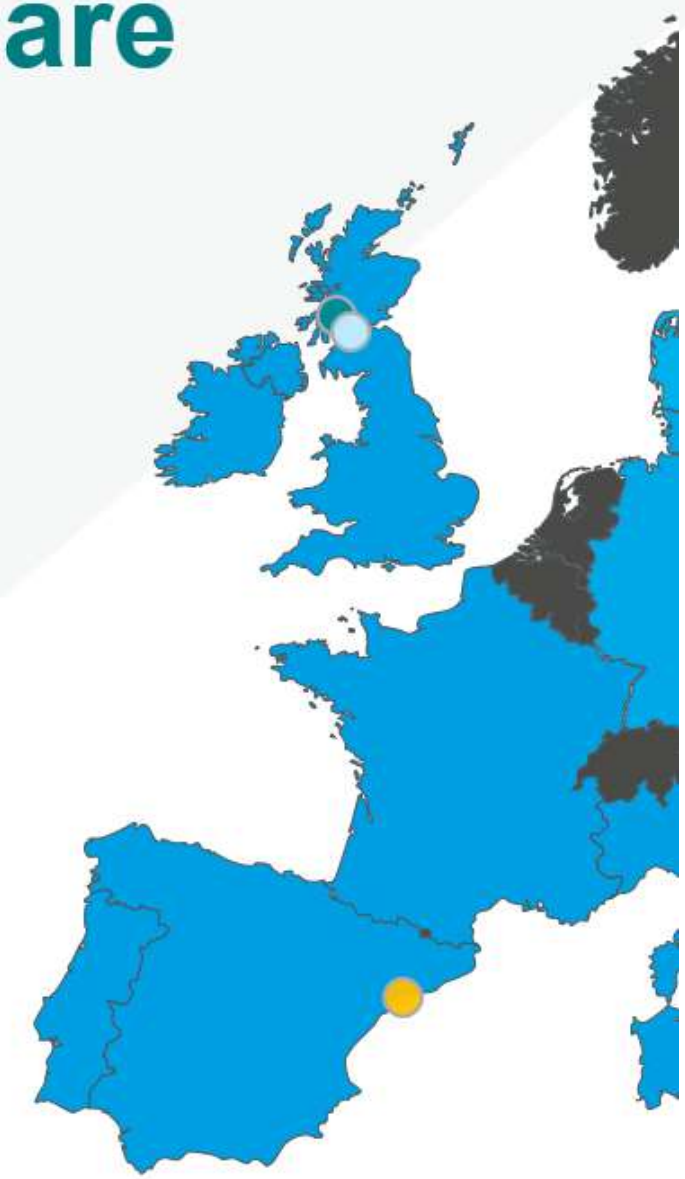
Refurbishment & Innovation Centre
Lochgilphead, Scotland

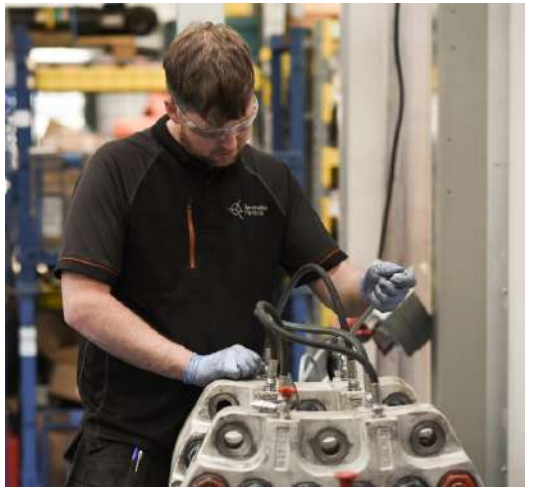
Operations & Logistics Hub
Renfrew, Scotland

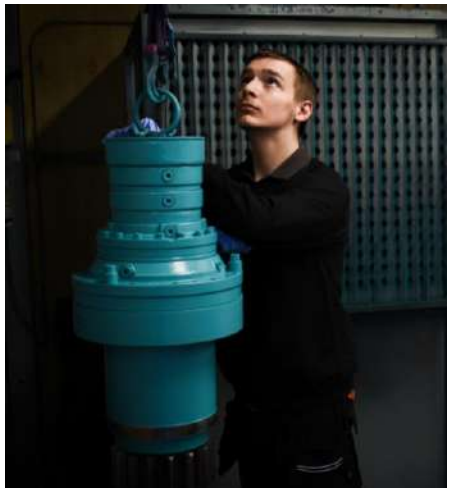
Supply Chain Operations
Various Countries

Local Representation
Spain

NEW: Renewable Parts LLC
Texas, U.S.







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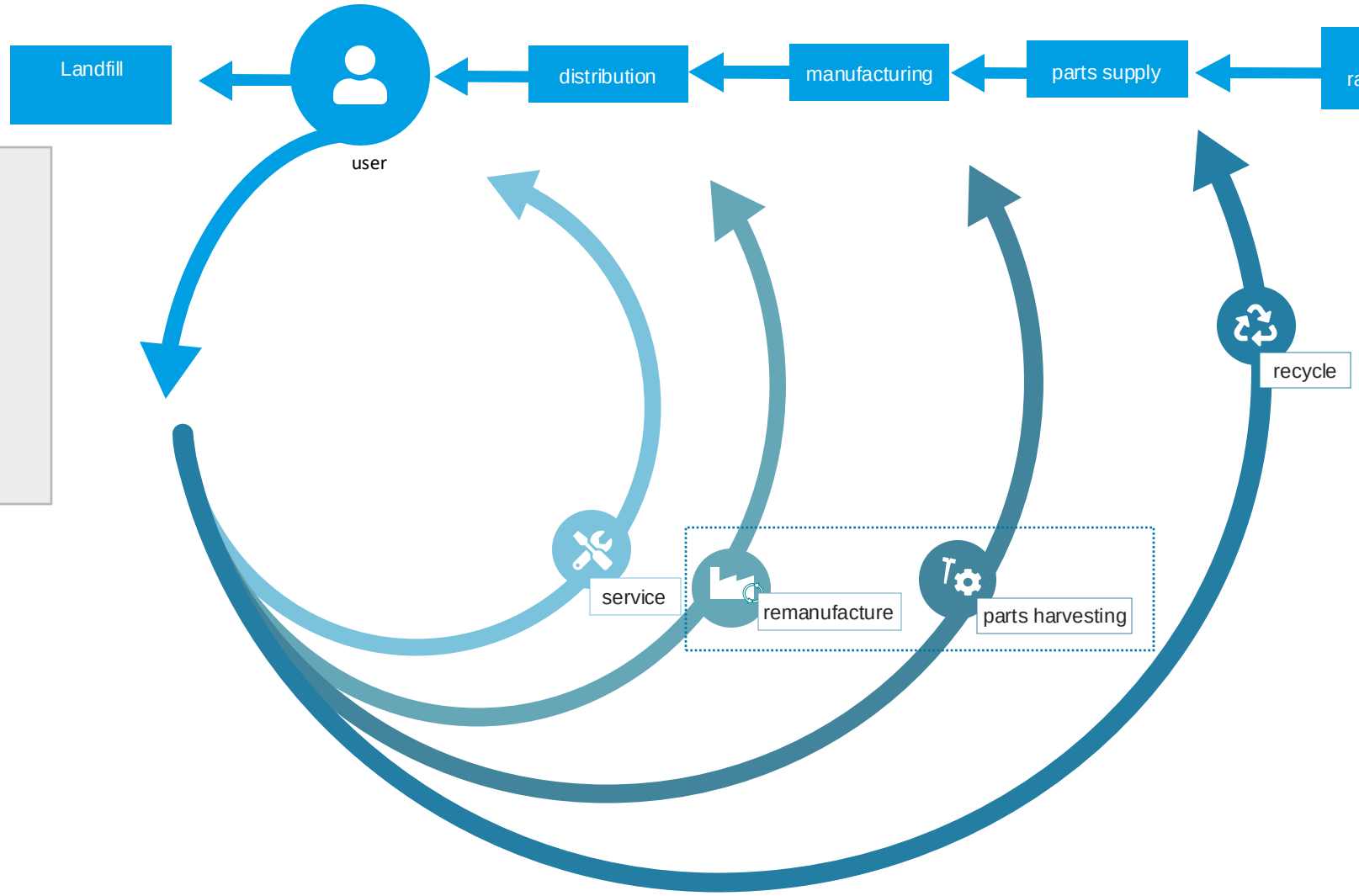
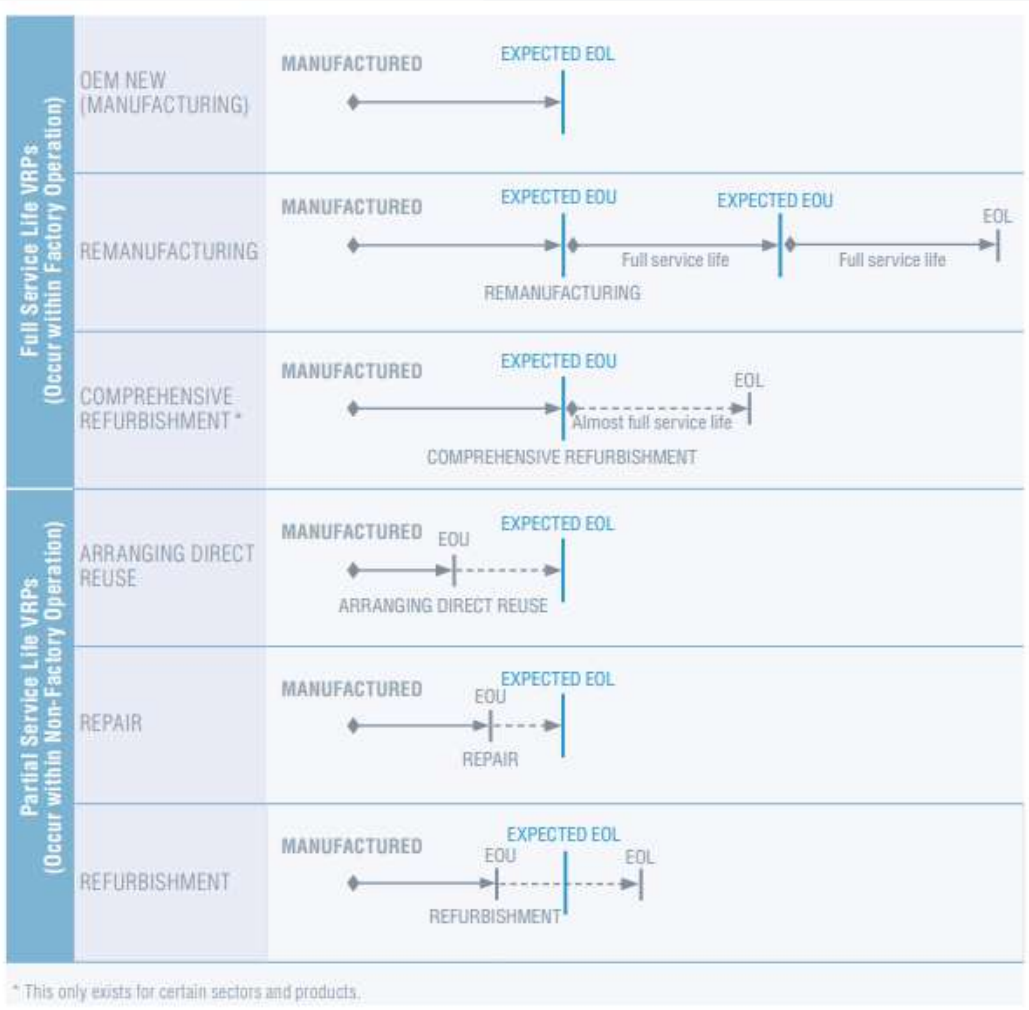
Recirculated Parts Overview

> A circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.

Ellen MacArthur Foundation



Value retention by recirculation



- Cost, warranty and expected service life vary with value retention process (VRP)
- Re-design (in addition to another VRP) can help to reduce failures & extend life, further reducing waste

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Ref: IRP (2018). Re-defining Value – The Manufacturing Revolution. Remanufacturing, Refurbishment, Repair and Direct Reuse in the Circular Economy. Nabil Nasr, Jennifer Russell, Stefan Bringezu, Stefanie Hellweg, Brian Hilton, Cory Kreiss, and Nadia von Gries. A Report of the International Resource Panel. United Nations Environment Programme, Nairobi, Kenya.

Recirculated Parts

Disassembly & component inspection

Components suitable for re-use

Components suitable for re-make (repair, refurbishment, remanufacture)

Components requiring re-design & modification for performance enhancement

Components unsuitable for re-use or re-make

Material value retention (Repurpose/Recycling)

Re-assembly & test

Components replaced by new

Components replaced by approved alternative (reverse engineered & manufactured parts – like-for-like)

Components replaced by reverse engineered & manufactured parts – re-design for performance enhancement

Our recirculated products can follow any combination of these production paths

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Case Study: 1.3 and 2.3CS Yaw Gears

June 2018
AMRL project start. Materials research for stage 4 planetary carrier. Fatigue analysis. Inspection of new and used components

November 2018
AMRL project finish. DMEM project begins – Enhanced inspection techniques and detailed analysis of components

April 2019
Work begins on reverse engineering of stage 4 planetary carrier

June 2019
1st set of Siemens 2.3CS gears sold to SSE

October 2019
DMEM project conclusion and results shared with RPL

December 2019
Start of yaw gears dampening project with SSE. Development of design followed by bench test to prove concept

June 2020
First of "quick fit" gears sold – Filled with oil and fitted with studs, and valves in advance

August 2020
Gear dampening project – Kits and modified gears issued for trial

November 2020
Approval of Co-Innovate strand 4 funding for "Engineering Project Lead" to investigate failures and work in improved processes and testing

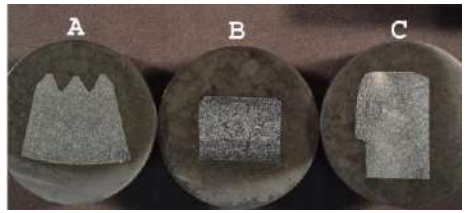
December 2020
First of UK cast and machined planetary carriers arrive for testing

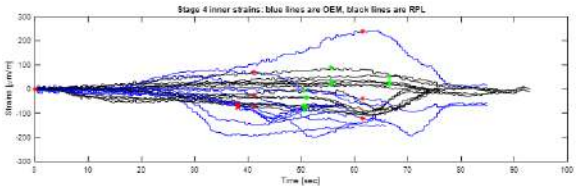
October 2021
Initial carrier tests complete and analysis of results begins

2022
Planetary carriers approved for controlled introduction into service; Dampening kits rolled out in-service

2023
Positive feedback from dampening kits, roll-out continuing; Production batch of RPL manufactured carriers ordered for production roll-out

- Circular supply chain for replacement gears – improved availability & reduced cost
- UK supply chain for replacement planetary carriers
- 'Dampening kit' introduced to reduce in-service failure rates
- 'Quick-fit' assembly configuration for time saving at site
- Data gathering for customer insights





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Recirculated Parts

Research & development: in-house, with academic partners & with trusted third parties

In most cases parts have an equivalent warranty to new & are serialised for traceability

Return of used part a condition of supply

Reverse logistics; custom frames and packaging

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Recirculated Part Capability

Blade	Pitch	Main Shaft	Gearbox	Brake	Highspeed Shaft	Generator	Hydraulic	Yaw System	Wind Instrument	General	Cooling System	Electrical	
Grease system	Pitch cylinder	Lubrication / grease system	Filter assembly	Brake caliper	Highspeed shaft	Lubrication / grease system	Valves	Yaw gear/motor	Wind vane	AV mounting assembly	Oil cooler	Circuit breaker	Multi-function relay
	Pitch slip ring		Filter housing			Coupling / slip ring	Pump & motor assembly	Yaw caliper	Anemometer			Motor	SKiiP modules
	Pitch motor		Oil pump & motor						Ultrasonic anemometer			Slip ring	I/O modules
												Power module	Main computers
												Phase module	Hub modules
												Processor	Connection module
												Switch fuse	Thyristors

RPL refurbishes a range of different components both in-house and through trusted third parties

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Benefits & Challenges

Why buy recirculated parts?

SUSTAINABILITY – Reuse of component parts avoids the need for new manufacture. In a typical refurbished Siemens 2.3CS yaw gear, reuse of component parts results in a ~400kg CO2eq saving relative to buying a whole new gear

QUALITY – Parts refurbished or remanufactured to restore as-new characteristics, with a warranty equivalent to new. Components subject to wear, affecting life or reliability, are replaced with new where possible: a superior product to repair.

AVAILABILITY – Stock held of high consumption parts for off-the-shelf availability, offering a significant advantage over OEM lead-times for new (defective parts to be returned for feed stock following receipt of recirculated products) plus obsolescence mitigation

COST – In most cases recirculated parts offer a cost saving relative to new. Costs are more stable than OEM and are set to accommodate variation in the condition of the returned defective units without impact to customer.

DATA – Every defective unit supplied to RPL is serialized and findings from disassembly recorded, allowing common failures to be identified and correlations back to turbines and sites made (if data supplied by customer).

SOCIAL & ECONOMIC – Creation of green jobs in the UK and the additional social benefits those bring

Main challenges

PERCEPTION – Perception of the quality of reman/refurb compared with new continues to limit uptake, particularly where cost saving relative to new is lower

ECONOMICS – The cost of comprehensive reman and refurb solutions can be close to the cost of a new, meaning operators either buy new or cheaper repair options, the latter often feeding negative perceptions

DATA – Much of the data which would allow for a more efficient scale-up is either not collected or not available to those that need it (e.g. failure rates, bills of material, parts lists, design requirements, etc.)

COMPONENT PART AVAILABILITY – Unavailability due to obsolescence or OEM protection, either limit ability to refurb or drive cost beyond economical

PROCESS – Many minor parts continue to be scrapped at site, either because processes aren’t in place to consider alternatives, or because processes are in place which actively restrict material moving into a circular loop

Coalition for Wind Industry Circularity (CWIC)

- What?
  - An industry programme launched by RPL, SSE Renewables, and the National Manufacturing Institute for Scotland (NMIS) as part of the University of Strathclyde
  - Aims to deliver sector-wide strategies & solutions for a more sustainable wind industry, with an increased focus on reuse and remanufacture of parts to reduce waste and carbon emissions and realise the significant financial benefits to the UK of growing a circular supply chain
- Who?
  - Over 45 members, ranging from political observers, to universities, and industry peers – including: Scottish Power Renewables, Orsted, The Crown Estate, Zero Waste Scotland, Statkraft, TotalEnergies, RES, and Scottish Renewables.
- How?
  - Developing parts remanufacture solutions
  - Establishing collaborative partnerships
  - Working with government to influence policy
  - Developing people and skills

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Thank-you

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