DIAMETER

# Transforming Metal Manufacturing for a Green Future

*A Horizon Europe Innovation for Circular Additive Manufacturing*

**L. T. Tunc** · Project Coordinator, Sabanci University

ManuDays26 · Brussels · 18 November 2026

# Why Change is Urgent

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## Manufacturing in Europe

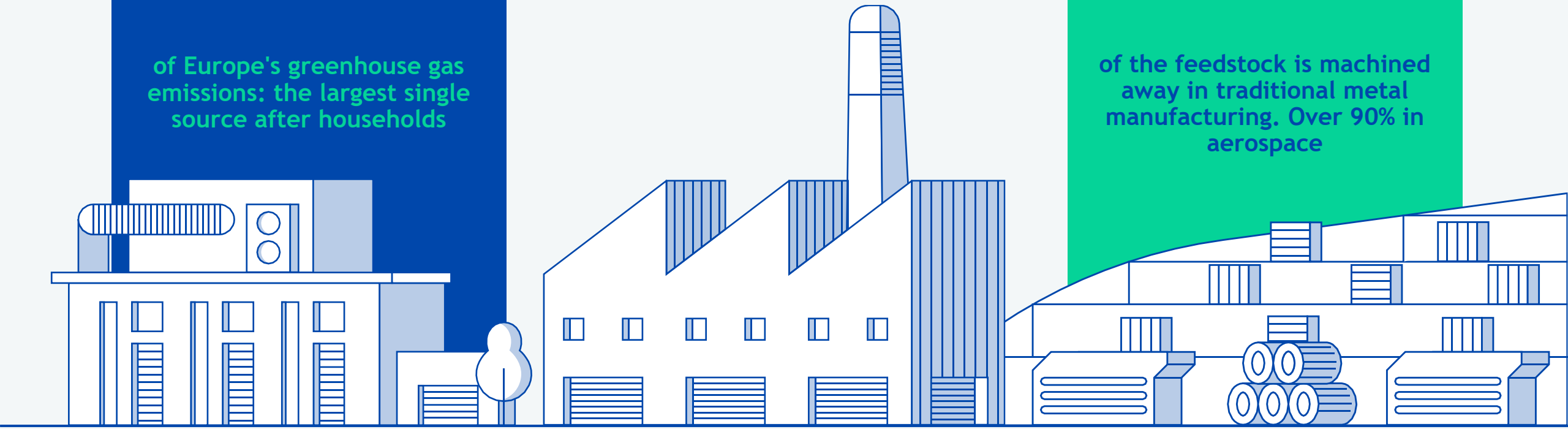
**20%**

of Europe's greenhouse gas emissions: the largest single source after households

Metal additive manufacturing can help, but it is not automatically greener: the result depends on the part, the material, the energy mix and the machining needed afterwards.

**50–60%**

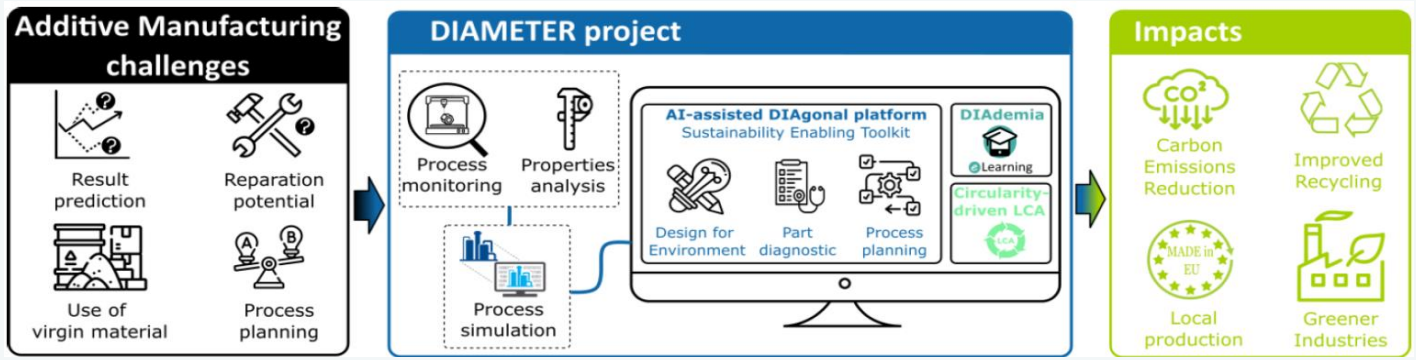
of the feedstock is machined away in traditional metal manufacturing. Over 90% in aerospace



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# Objectives

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| DIAMETER database | Circularity-driven LCA algorithm | Design for Environ. algorithm | Circular Sustainability Evaluation algorithm | DIAdemia | DIAgonal | DPP Integration |
|---|---|---|---|---|---|---|
| 31 Jan 2026 | 31 Oct 2026 | 30 Apr 2027 | 30 Apr 2027 | 31 Oct 2027 | 31 Oct 2028 | |

## Evaluation of AM Processes

ManufactuRE, REpair, REmanufacture, REcycle

Part performance

Sustainability

Life Cycle Analysis & Costing

## Upskilling Workforce

UPTake of requires long time

## Process Planning

Tool path Generation

Interaction of AM + Machining

## Eco-Design

LCA-LCC driven CAD/CAM

AI-Assistance

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement 101177422

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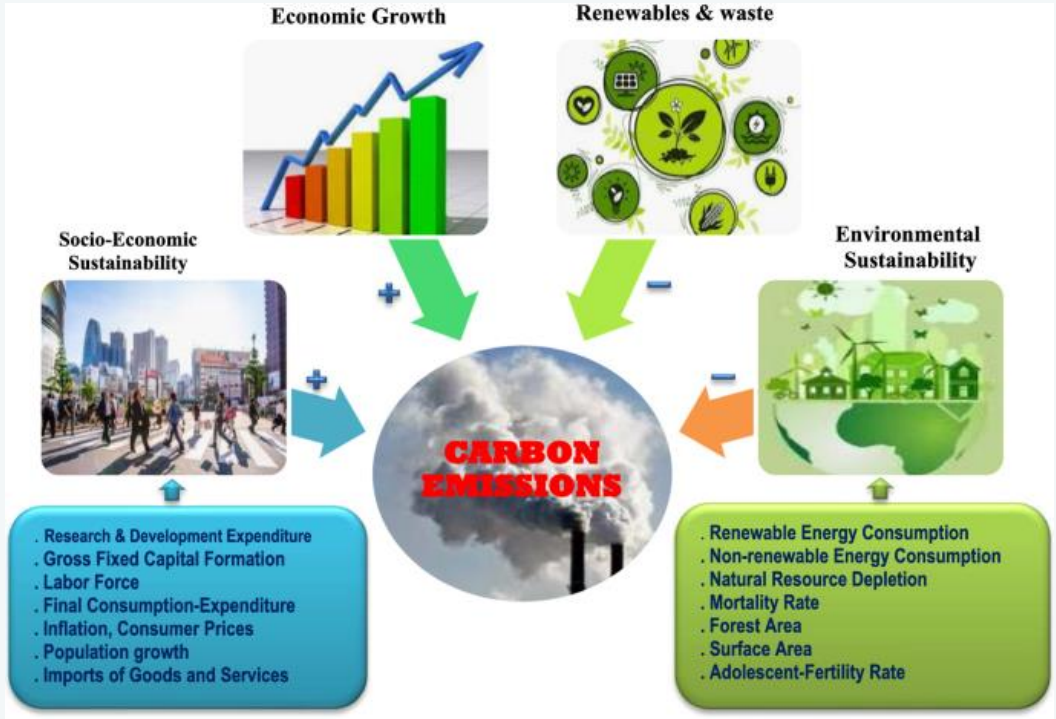
# Objectives

**Objective 1:** Assess the ecological and economic sustainability of circular-by-design manufacturing

**Objective 2:** Develop an AI-assisted, DIAgonal, to implement a circular economic model based on additive and subtractive manufacturing

**Objective 3:** Facilitate the implementation of circular economy

**Objective 4:** Foster circular manufacturing system adoption by the industry

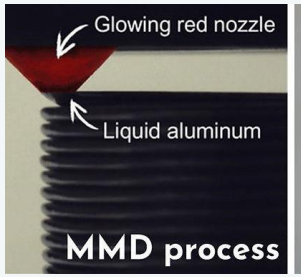



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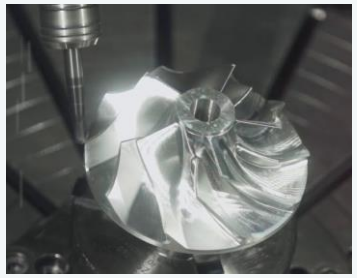
# Project Questions

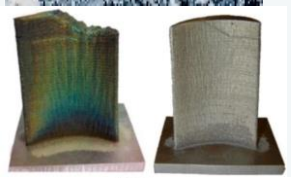
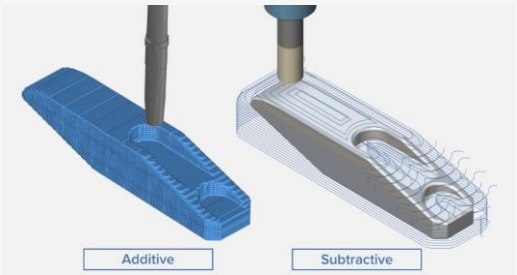
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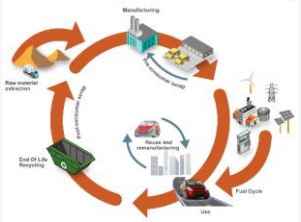
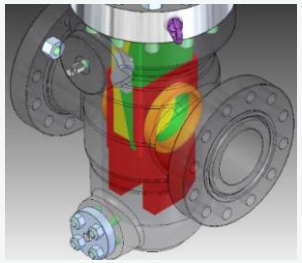
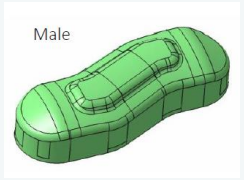





## Which AM process suits better ?

Circular-by-design

REpair – REmanufacture - REcycle

Material properties

Post-machining

Process plan

Monitor

## How to recycle metals for AM ?

Carbon footprint

Traceability

Origin

LCA

## How to accelerate UPtake ?

Industry

New graduates

Technical training

Real-process experience

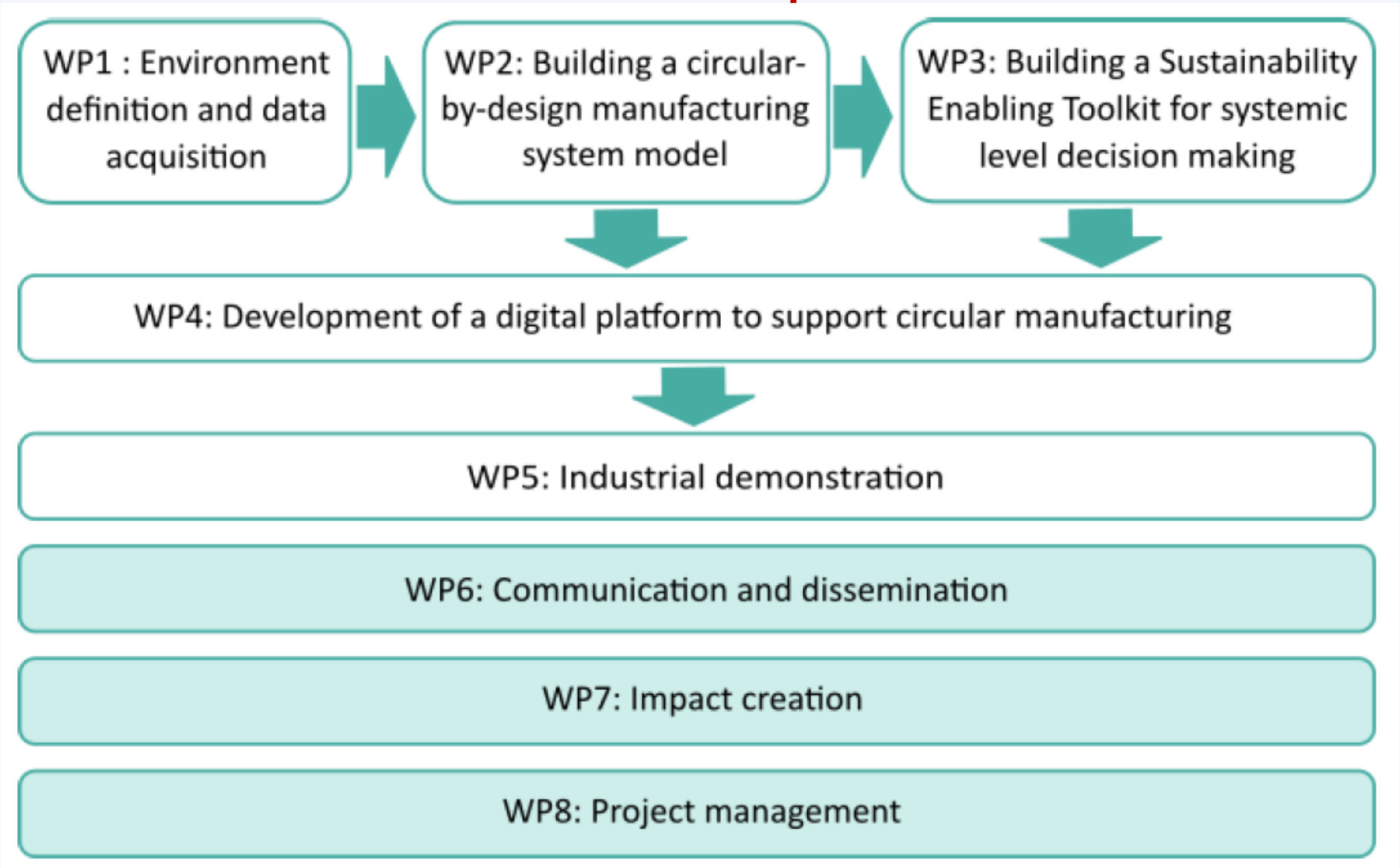
Simulation-based

Interactive

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# WP structure



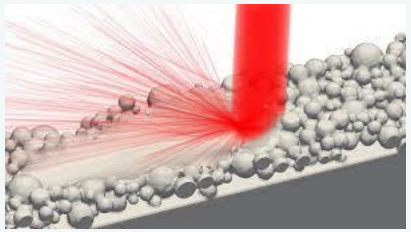

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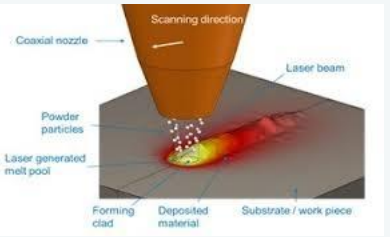
# Methodology

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## Simulation & Monitoring

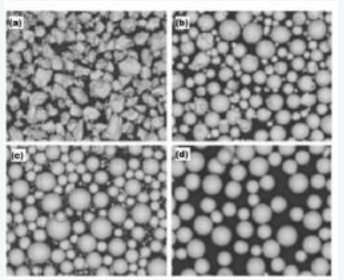
- Powder Bed Fusion
- Directed Energy Deposition
- Friction Stir Additive
- Molten Metal Deposition
- Electron Beam Additive
- Multi-Axis Milling

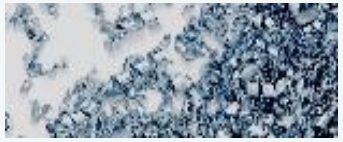





## Material

- Powder atomization
- Chip recycle
- Shape and purity analysis, Traceability, EU-DPP
- Recycling costs





## Workforce

- E-Learning Platform
- Process monitoring data
- Simulation data
- Use and importance of LCA




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# Methodology

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## Lice Cycle Assessment

AI-Assisted

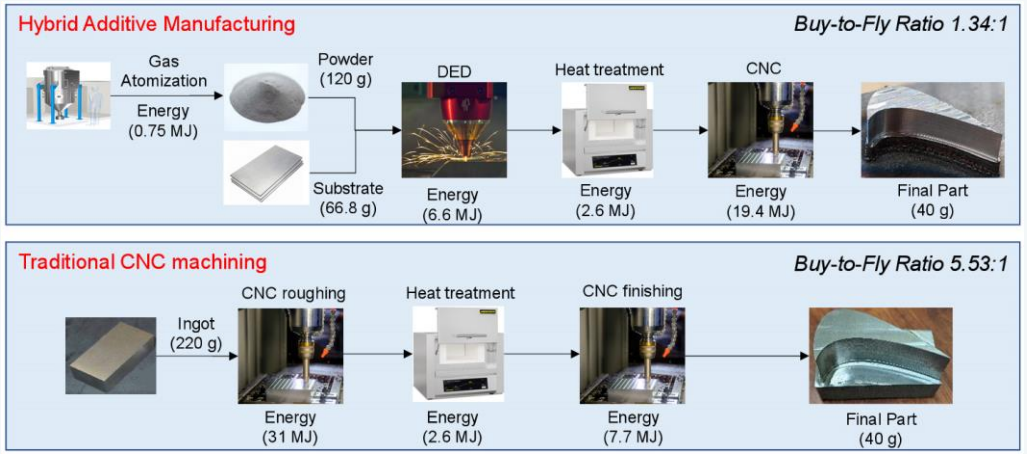
Material & Energy Flow

Resource Consumption

Recycling steps

Life Cost Cycle

KPI weighting & Close the loop




## Eco-Design

Design for environment tool for target AM technologies

**RE**Cycle, **RE**Pair, **RE**Manufacturing

Impact Comparison

## Process Planning

Consider AM and Machining as part of a process chain

Select suitable combination

Bilateral effects of AM and Machining

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# One Consortium, the Whole Value Chain

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**17**

**organisations**

16 partners + 1 associated partner

**10**

**countries**

across Europe, Türkiye and Australia

**48**

**months**

November 2024 – October 2028




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# From Data to Decisions

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1 **Measure** — Experimental data

2 **Model** — Simulation and AI

3 **Assess** — LCA and LCC

4 **Decide** — DIAgonal platform

5 **Demonstrate** — Industrial pilots

**Five pilot cases, one question:** which route gives the right quality at the lowest environmental and economic cost?

PILOT 1

## Catalytic converter

MMD · EBM

Aluminium, copper

ValCUN · KTH

PILOT 2

## Industrial valve component

Laser DED

Super duplex steel

TTS · Valland

PILOT 3

## Landing gear bracket

AFSD

Aluminium 7075

AMRC · Turkish Aerospace

PILOT 4

## Stamping die repair

Laser DED

Repair on cast iron

TTS · Coşkunöz

PILOT 5

## Turbine blade

LPBF + milling

Inconel 718

Fraunhofer · Valland

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# First Results

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**The hybrid route works:** additive manufacturing gives the shape, machining gives the final quality.

## Valve component

Laser DED · super duplex steel

**99.8%**

relative density

Tensile properties meet the requirements in both build directions

## Turbine blade

LPBF + milling · Inconel 718

**>99.9%**

relative density

Surface roughness from Ra 4.5 µm to Ra 1.5 µm after milling

## Stamping die repair

Laser DED on cast iron

**-20%**

friction vs conventional surfaces

No cracking at the interfaces: the die goes back into production instead of being scrapped

# Measuring Impact

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1. **LCA and LCC models**
   built on real data from the pilots (ISO 14040/14044)

2. **33 scenarios**
   material–geometry combinations across five AM processes

3. **One integrated view**
   environmental and economic impact assessed together

## Where a part is made matters

One case study, EBM copper part

**≈2%**

share of the AM step in the part's carbon footprint, with the Swedish electricity grid

**10–25×**

more carbon-intensive electricity in Belgium, Italy or Türkiye

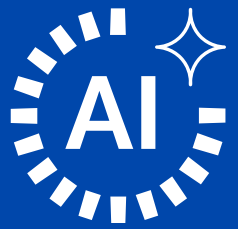
The same part can have a very different footprint depending on where and how it is made.
**Decisions need a tool that combines part, process and context.**

# Two Platforms

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## DIAgonal

In development · initial version mid-2027




**Will answer one question:**

**“How should I manufacture this part?”**

It will compare manufacturing routes by cost, carbon footprint and time, with data ready for the EU Digital Product Passport.

## DIAdemia

Live at www.diameter-eu.org



**Training** on additive manufacturing, circularity and the Digital Product Passport, and the **library of all DIAMETER results.**

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## What comes next

Industrial demonstrations on all pilots, open access publications, and both platforms carried beyond the project.

# Meet us this week

**ManuDays26 · 17–18 November** · DIAMETER booth, SILO Brussels

**Formnext · 17–20 November** · Frankfurt, Hall 11.0, Stand C77

Scan to visit our website

**www.diameter-eu.org**

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