



Presentation

Method for sustainability calculation of polymer AM – Overview, status quo and challenges

Additive Alliance

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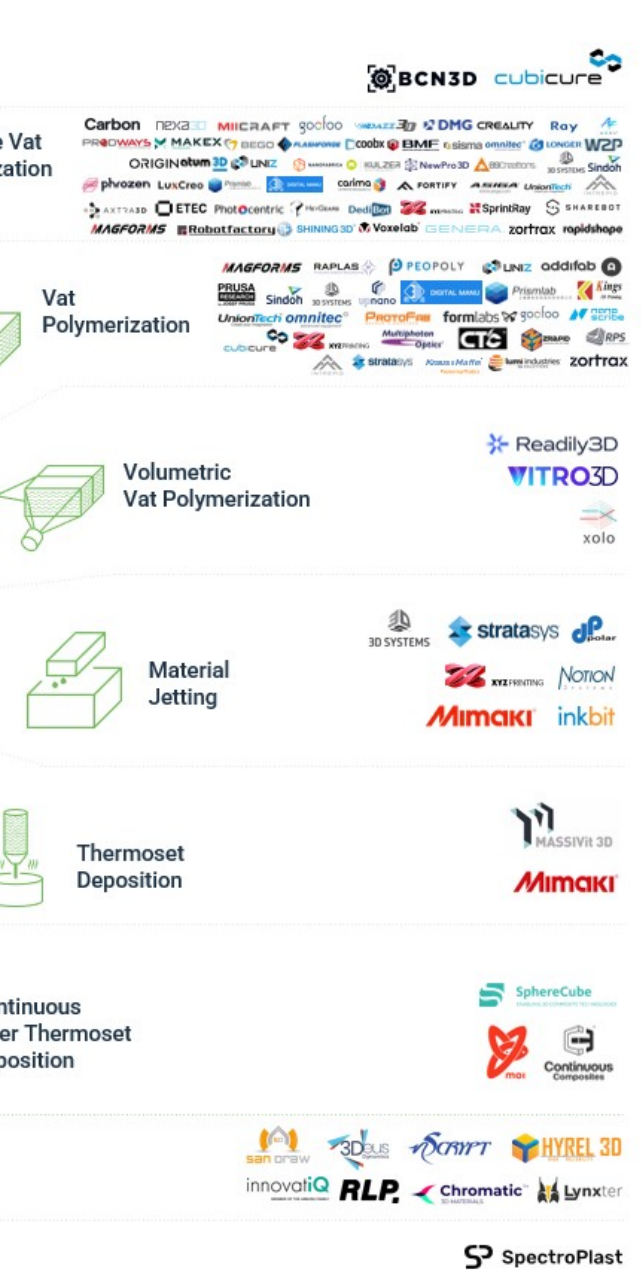
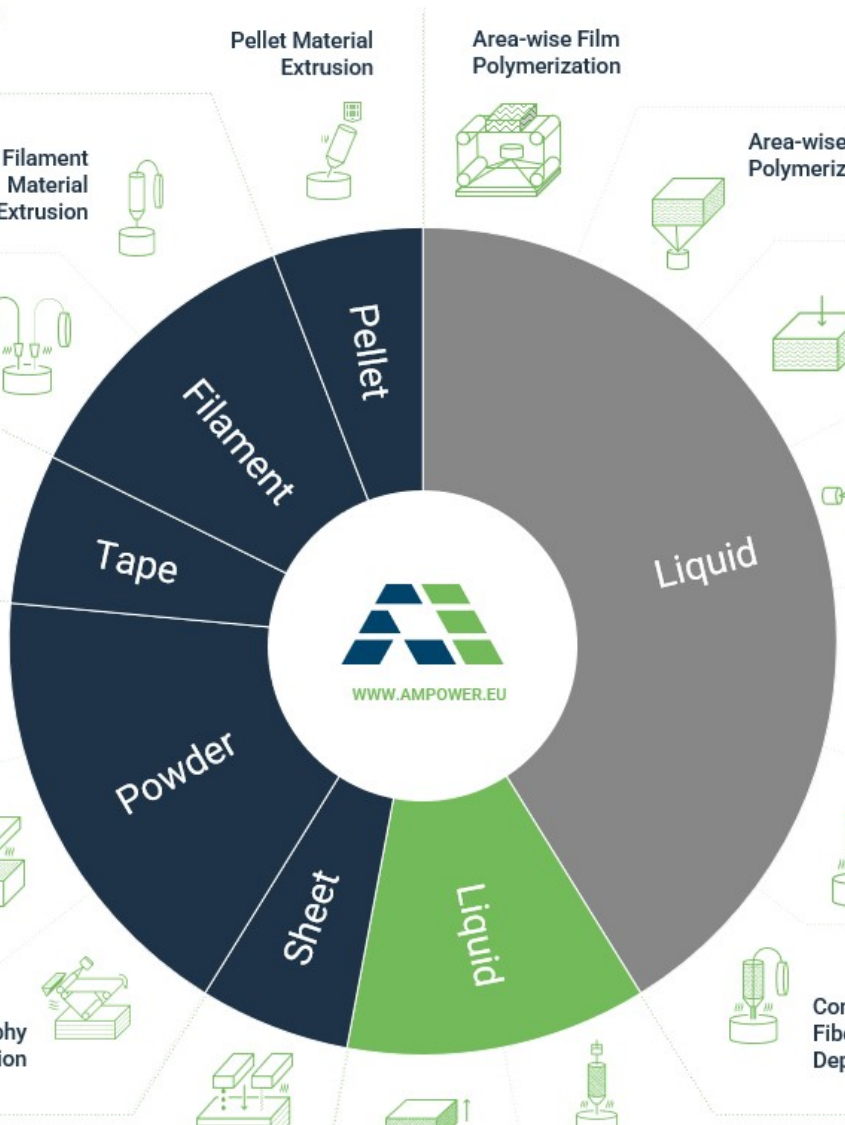
Hamburg 18.10.2023



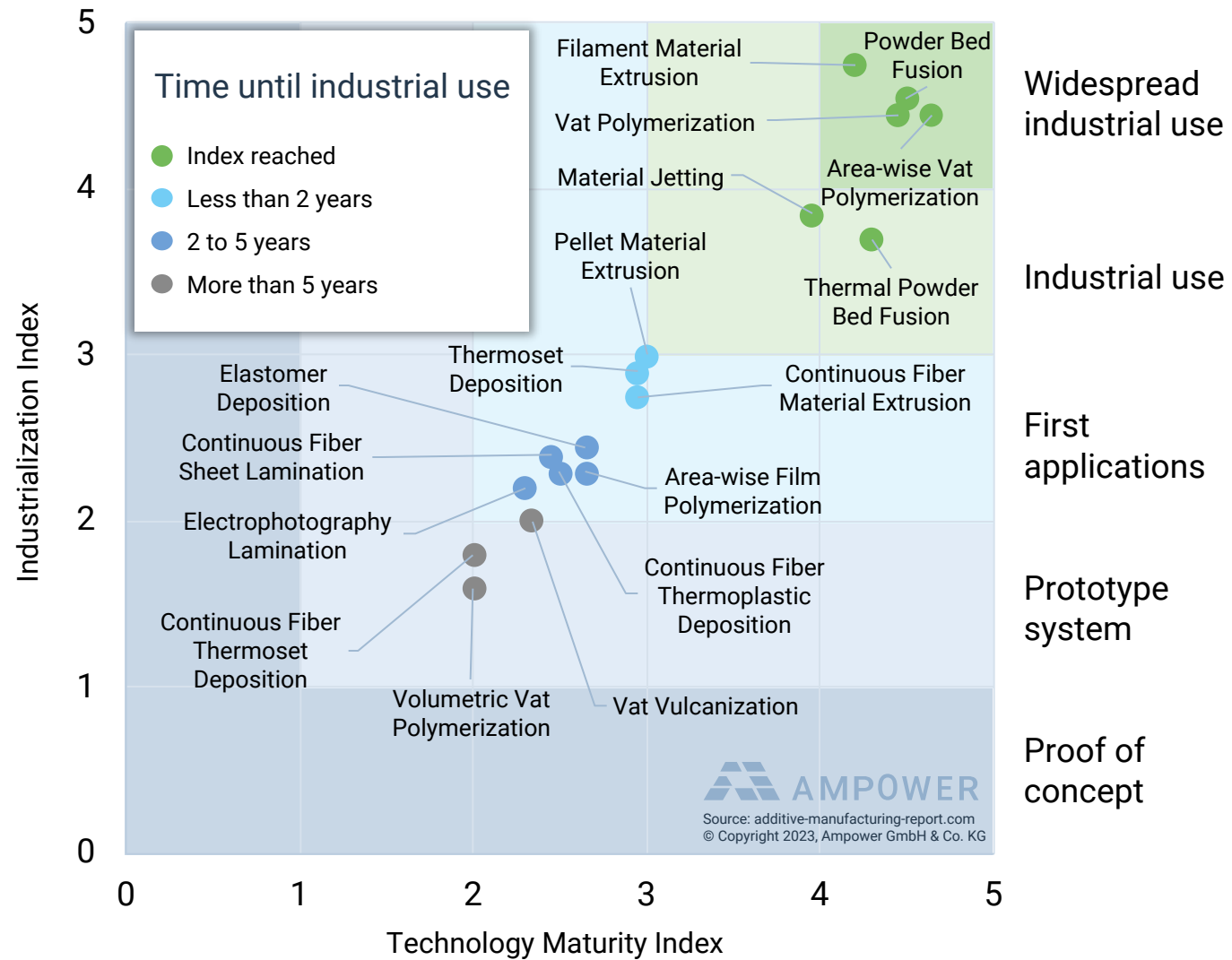
CONSULTING FOR ADDITIVE MANUFACTURING

AMPOWER

- Strong industrial focus with management and hands-on AM experience.
- Addressing investors, AM suppliers and end users.
- Providing market intelligence, strategy, technology assessment, machine qualification and operational excellence in Additive Manufacturing.

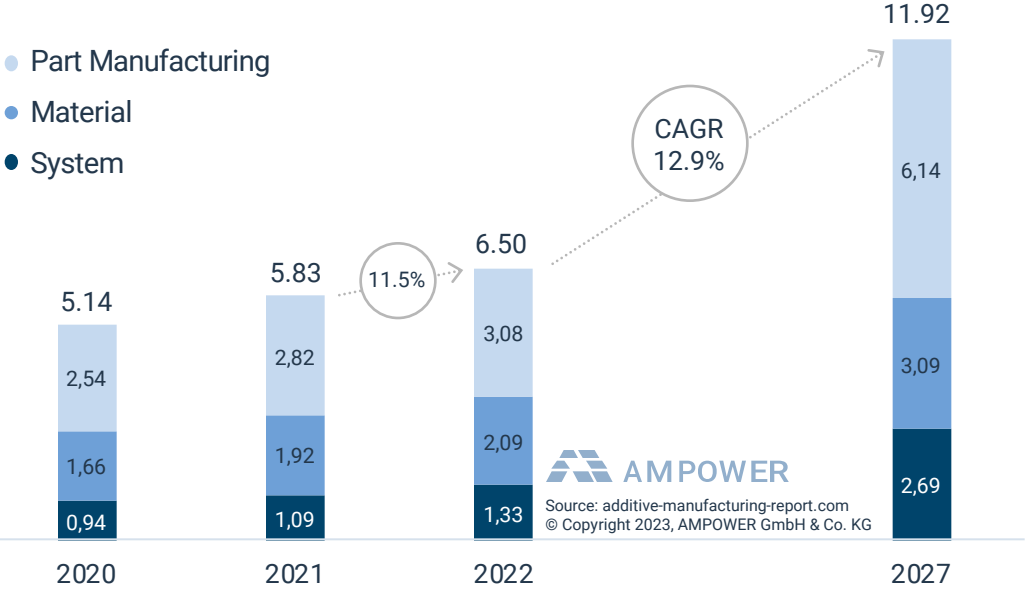


AM Technology Maturity Index

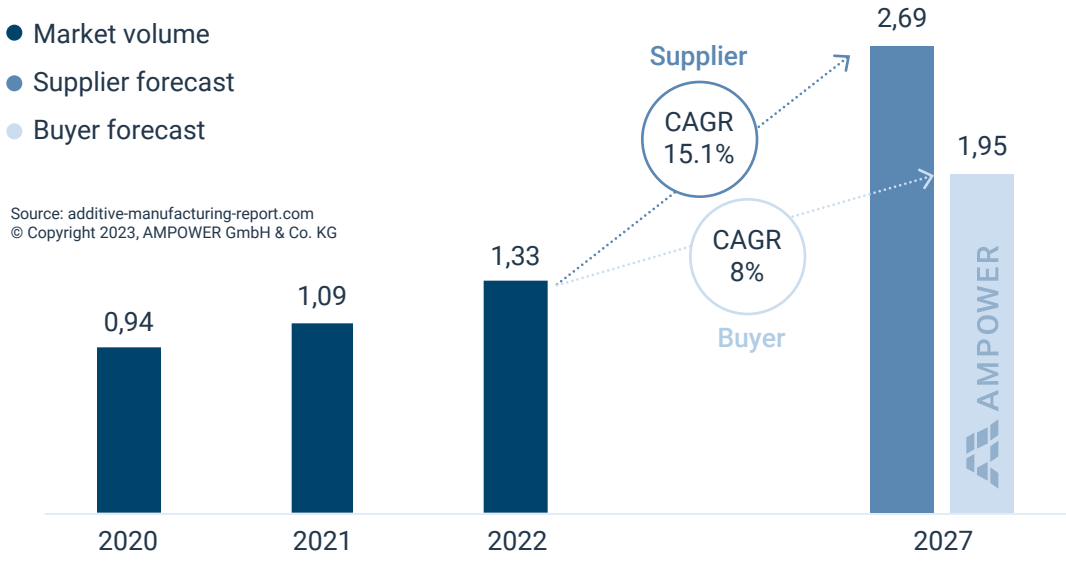


Polymer AM market with steady growth

Polymer Additive Manufacturing market 2020 to 2022 and supplier forecast 2027 [EUR billion]

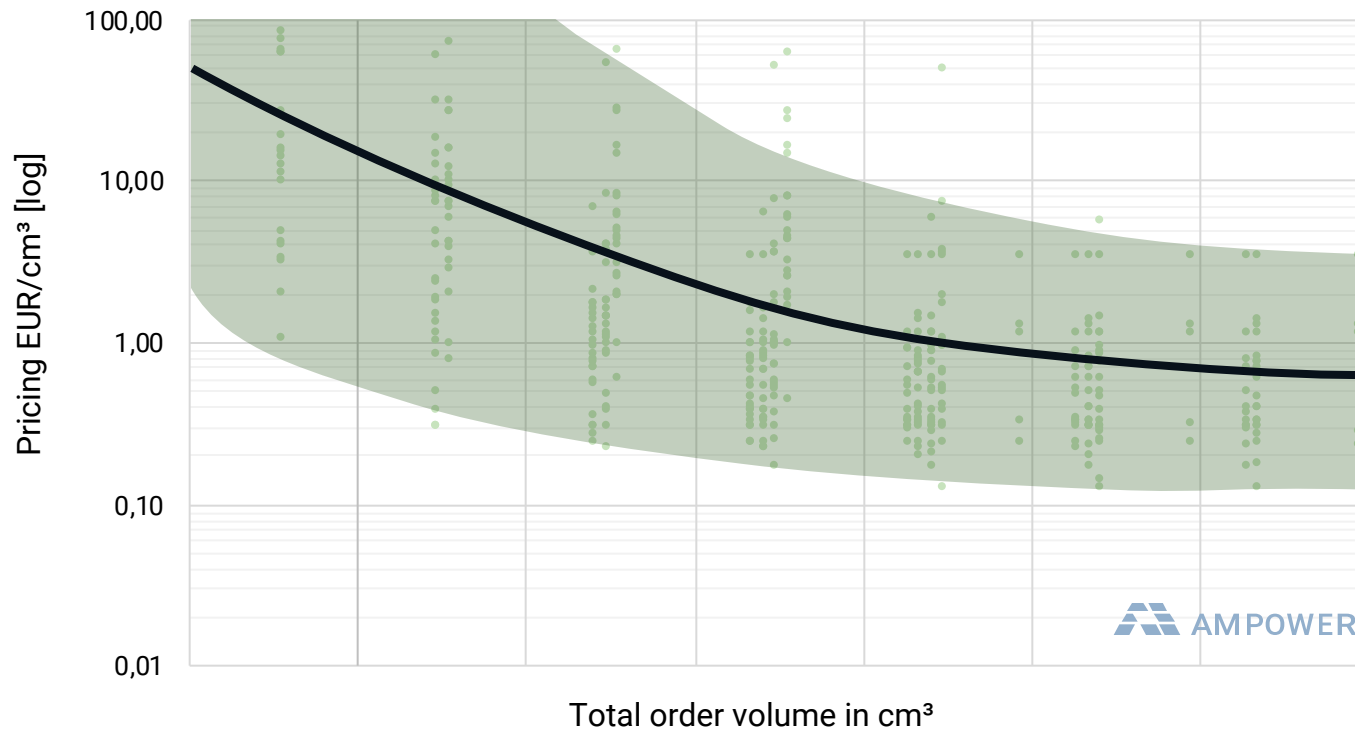


Polymer Additive Manufacturing systems market 2020 to 2022 and supplier vs. buyer forecast 2027 [EUR billion]



Large spread in market pricing of polymer AM parts

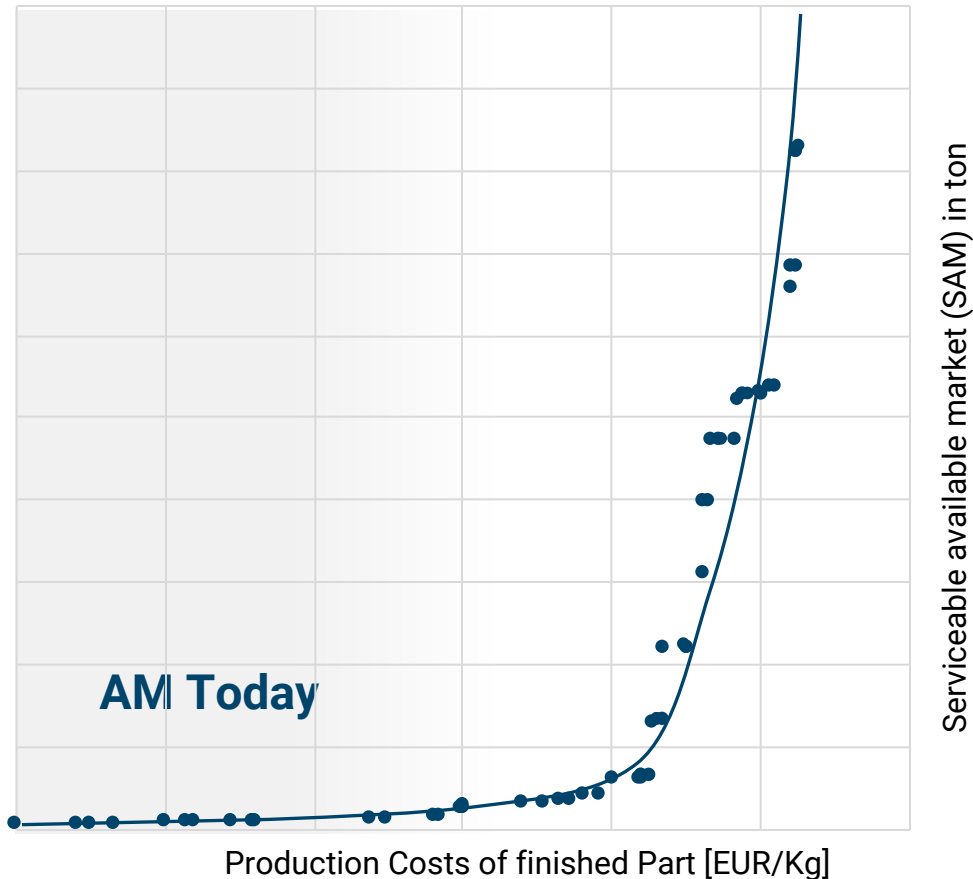
Polymer Additive Manufacturing pricing per volume in EUR/cm³ [log]
Laser Powder Bed Fusion (Selective Laser Sintering, SLS), PA12



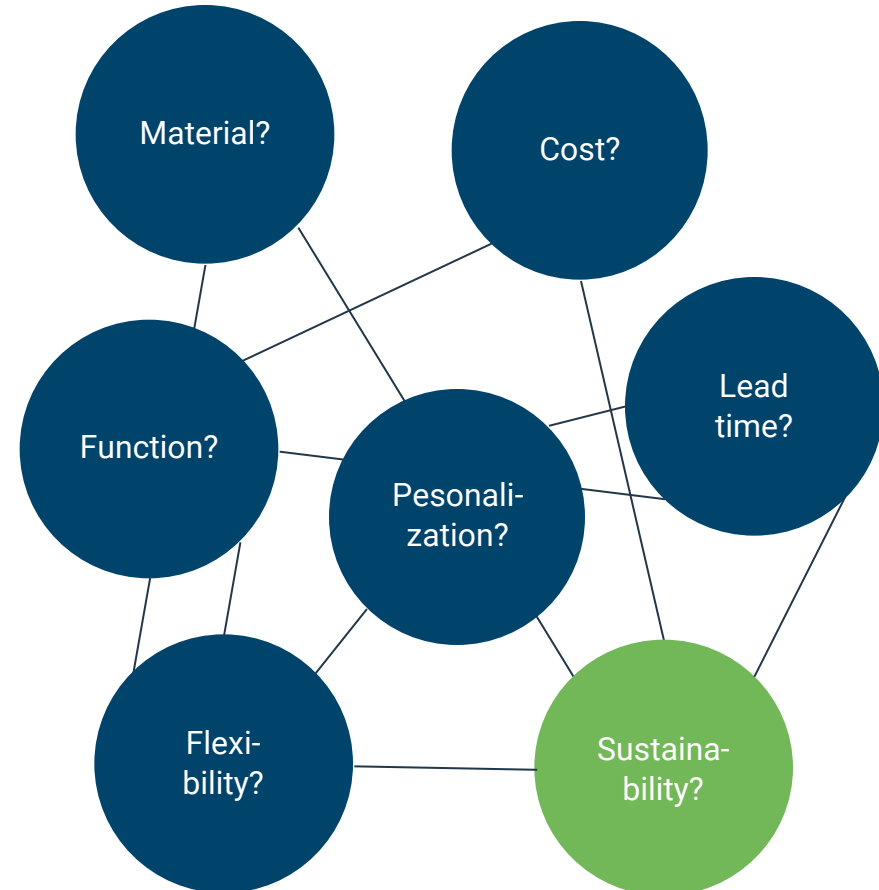
- Pricing in AM continues to be mostly **intransparent**
- AMPOWER market pricing study with **5,000 instant quotes** based on representative AM applications
- Price difference in polymer AM between **factor 10-15x for TPU and PA12**, and factor up to **factor 80x for ABS Material Extrusion**.

Polymer Additive Manufacturing market share is $\ll 1\%$ of the addressable market

Serviceable available polymer AM market depending on production cost



Potential drivers to switch to Polymer AM



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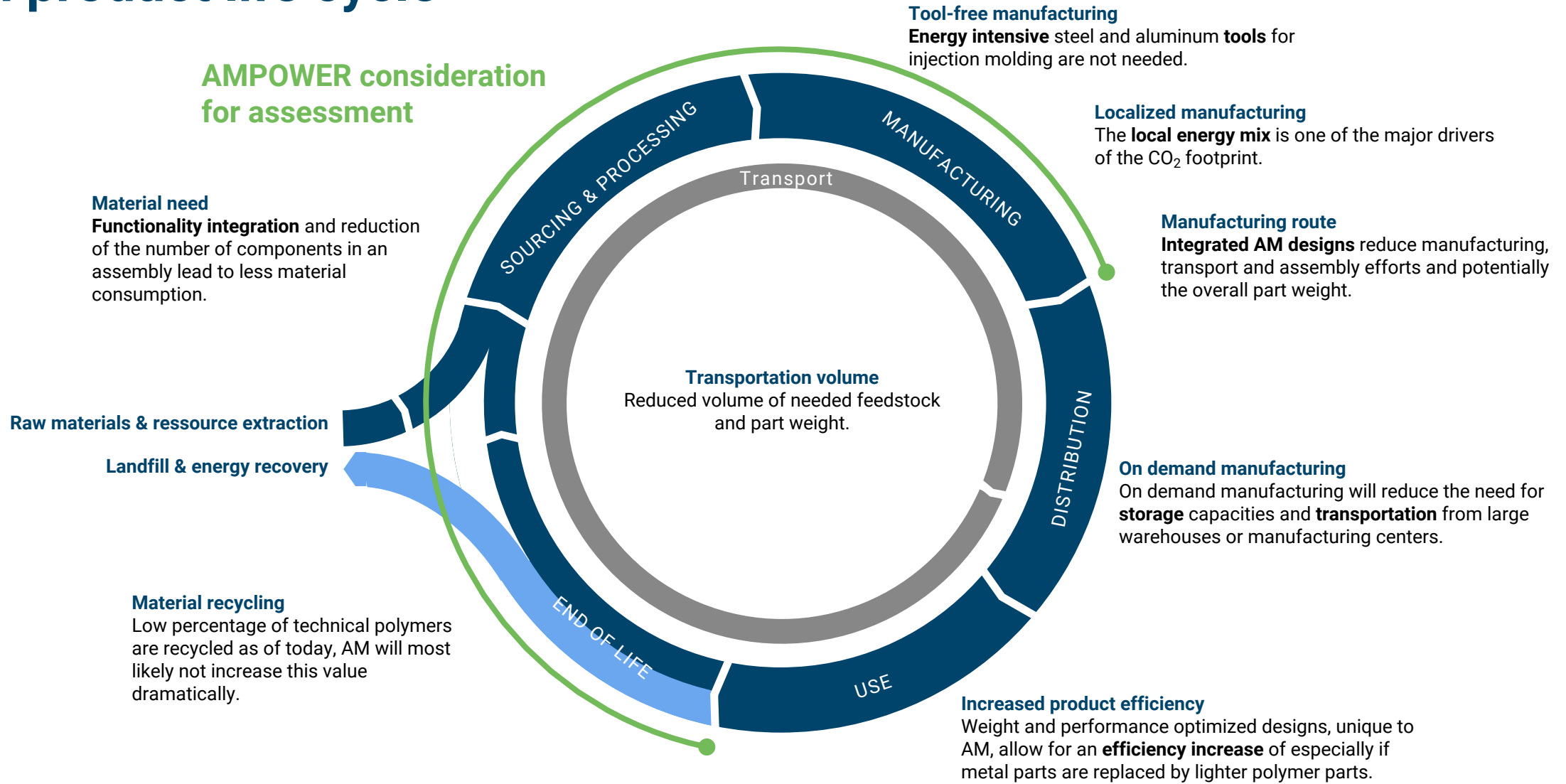
Lego ditches oil-free brick in sustainability setback

...Niels Christiansen [CEO] told the Financial Times that using recycled polyethylene terephthalate (RPET) would have led to higher carbon emissions over the product's lifetime as it would have required new equipment.

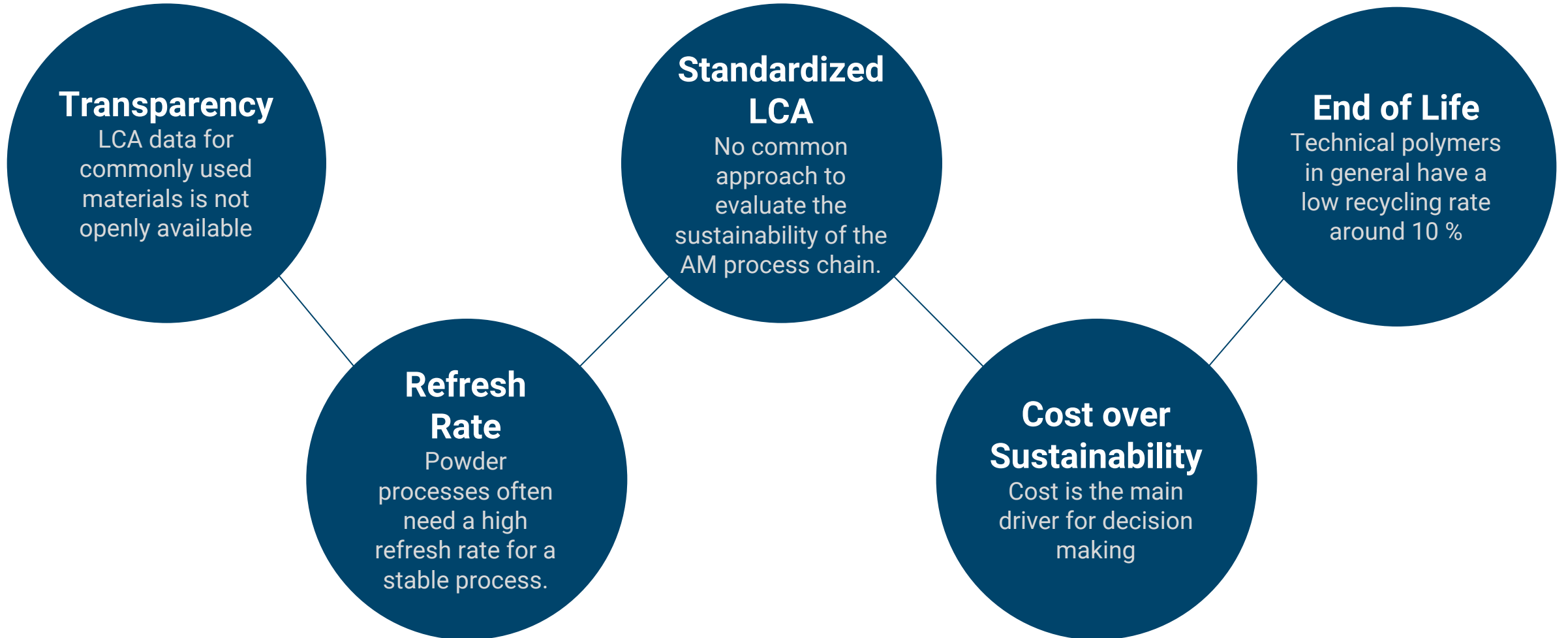
“In order to scale production [of recycled PET], the level of disruption to the manufacturing environment was such that we needed to change everything in our factories. After all that, the carbon footprint would have been higher. It was disappointing.” (Tim Brooks, LEGO head of sustainability)

Sustainability POTENTIAL of Polymer Additive Manufacturing in product life cycle

AMPOWER consideration for assessment



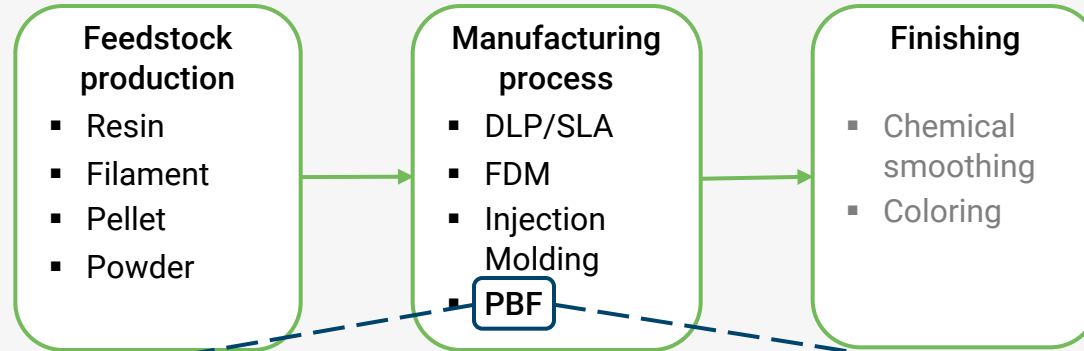
Challenges for assessment of sustainability of Polymer AM



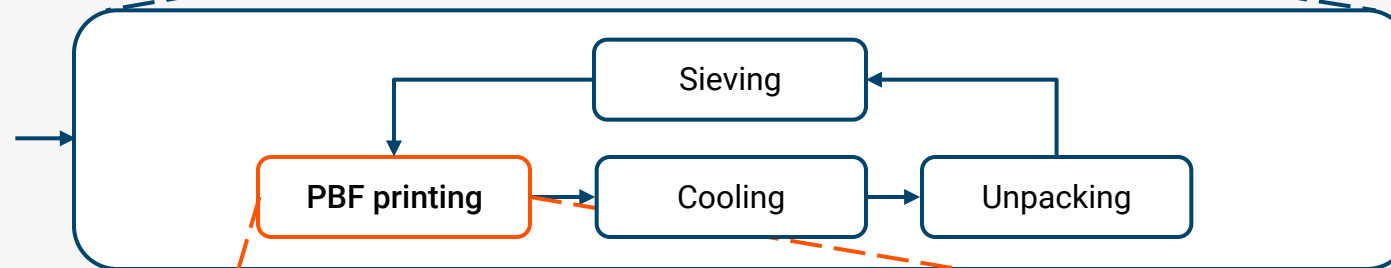
Approach and process model for CO₂ calculation

AMPOWER Sustainability Calculator

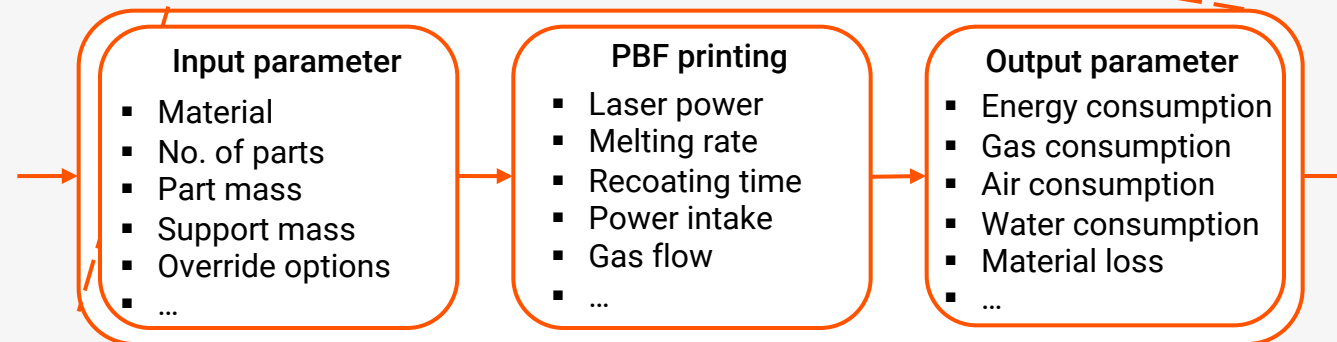
Process chain



Process



Process step



Development of a sustainability calculation tool

Dashboard



Easy to use tool for fast evaluation and comparison of ecological impact from different manufacturing technologies.

Dashboard

- Entry of part-specific parameters
 - Part characterization by as little parameters as possible
- Visualisation of results
 - Primary energy consumption and CO2 footprint per part
 - Sustainability Index incl. water, gas, oil & consumables consumption weighted via Eco-Indicator 99 or similar

Process data

- General and process-specific data sets
- Standard values will be researched and provided with sources (e.g. measurements, expert interviews, ecoinvent database)
- Override for individual adjustment possible

Calculation back-end

- Calculation of energy and material consumption

Sustainability of Polymer Additive Manufacturing

1

AM technologies are not self-evidently the most sustainable manufacturing solution. Utilized conventional near net-shape technologies will most likely exhibit a similar or smaller CO₂ footprint.

2

Optimized refresh rates of powder will have a significant impact in reducing the CO₂ footprint. Low refresh rates will yield break-even at low lot sizes compared to traditional methods (injection molding).

3

In-use savings of weight by e. g. replacing metal with polymer parts can be multitudes larger than the emission from part production itself. However, in-use savings are strongly depending on the application.

4

Use of renewable energy in the raw material production process has a major influence on the overall CO₂ footprint.

5

Public LCA data for the material manufacturing process of powder, filament and resin is almost not existing. Some material suppliers, however, are slowly starting to provide this data.

6

First calculations of the sustainability of AM show rather disappointing results for polymer AM vs. injection molding. We are currently awaiting firsthand data of AM materials for calculation.



Thank you for your attention!

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