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ESSIAL

Final infoday: Assembly process

ESIEE AMIENS

CRM GROUP

IRT m2p INSTITUT DE RECHERCHE TECHNOLOGIQUE MATÉRIAUX MÉTALLURGIE ET PROCÉDÉS

Multitel INNOVATION CENTRE

UNIVERSITÉ de Picardie Jules Verne

uc3m Universidad Carlos III de Madrid

SCHALTBAU SEPSA

JEUMONT Electric Groupe Altawest

matikem DE L'IDÉE AU MARCHÉ

andaltec CENTRO TECNOLÓGICO DEL PLÁSTICO

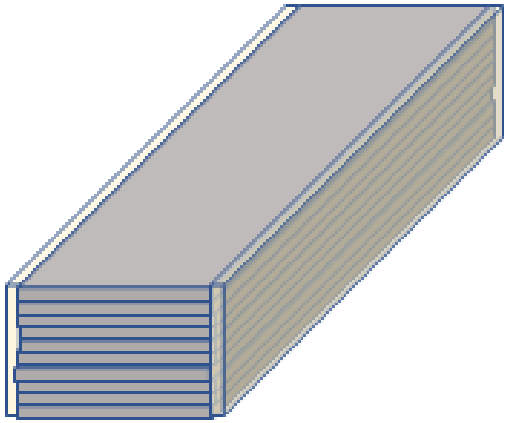
Fraunhofer IPT

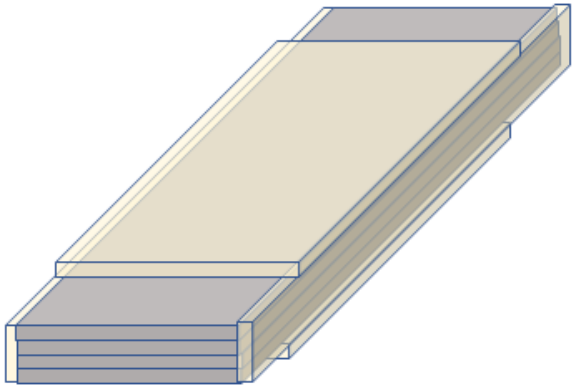
lasea PRECISION LASER SOLUTIONS

euronovia

Improve magnetic sheets assembly by means of plastic-metal laser welding

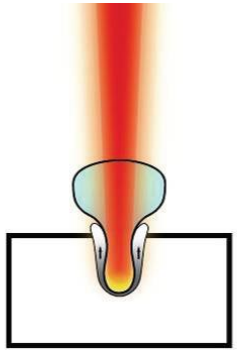
- It must create **sufficient bonding** at nominal temperature to keep strongly joining all sheets as well as allow an easy removal process.
- It must allow **avoiding screws**, which reduce overall efficiency.
- It must be **environmentally-friendly**, therefore the dismantling have to be easy

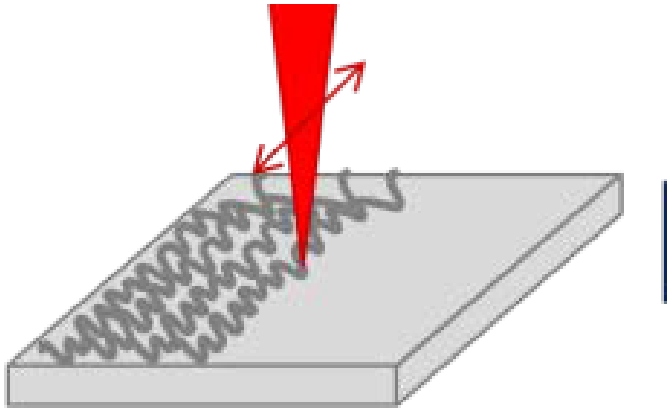




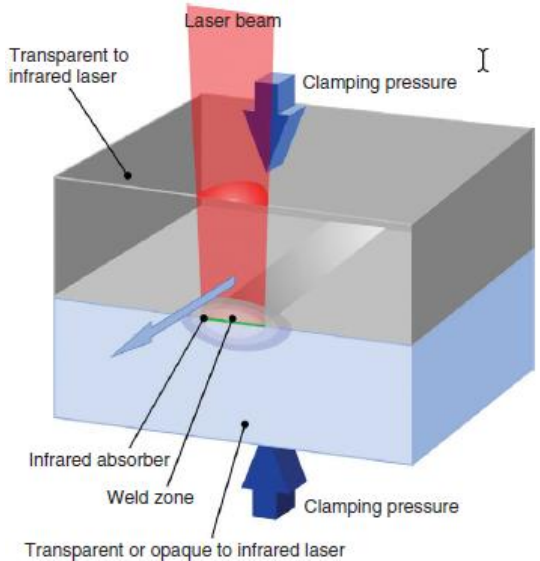
Plastic metal laser welding

Laser radiation is used to ablate the metal surface and create microstructures with undercut grooves.

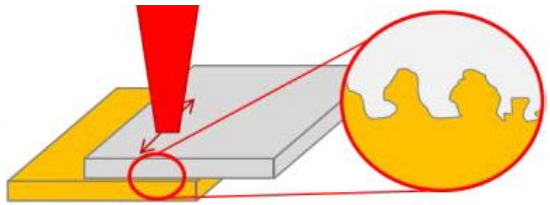




Plastic material is place above the metal and a laser beam passes through the plastic to heats directly the metal surface. When the above plastic part is heated because of the high temperature in the metal surface, the plastic melt and expands into the microstructures. External clamping pressure is needed also



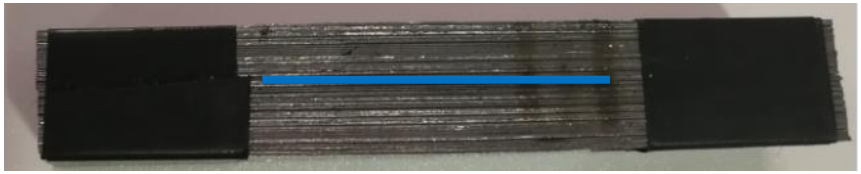
Video



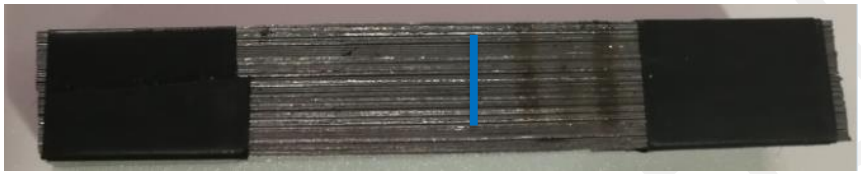
Frist trial of assembling processes

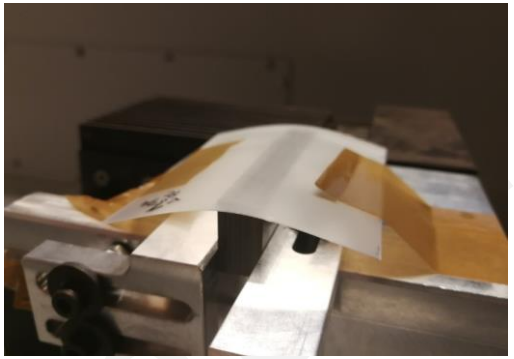
Study of joining without micro-structurations

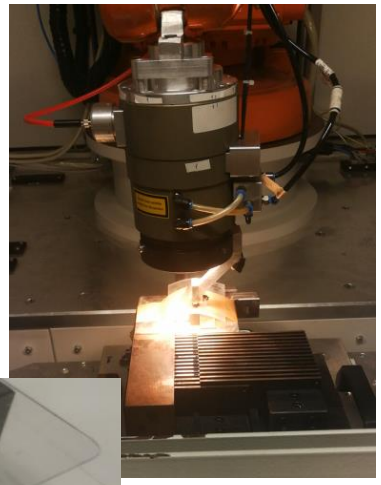
Longitudinal direction



Transverse direction







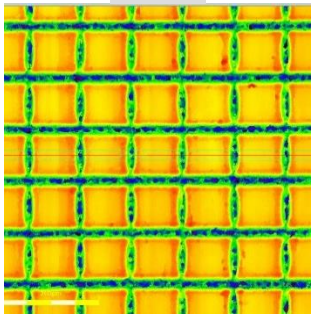
Metal sheets detached from the polymer sheet.

- Necessary to design and manufacture a new tooling for clamping
- Necessary to perform micro-structurations to ensure mechanical robustness

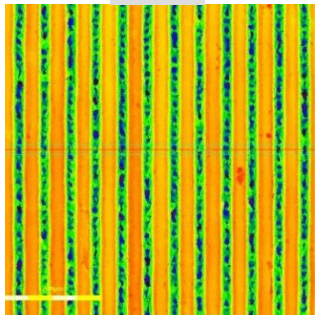
→ laser micro-structuration study needed

Microtexturization process

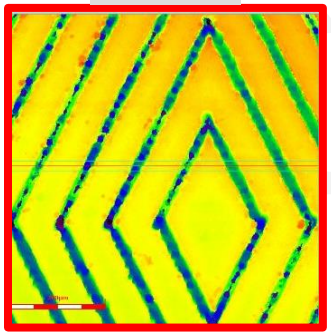
Grid



Line

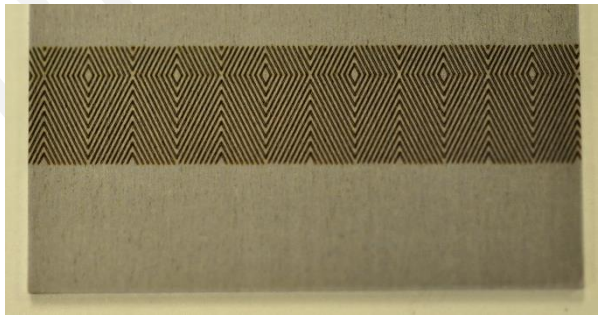


Lozenge

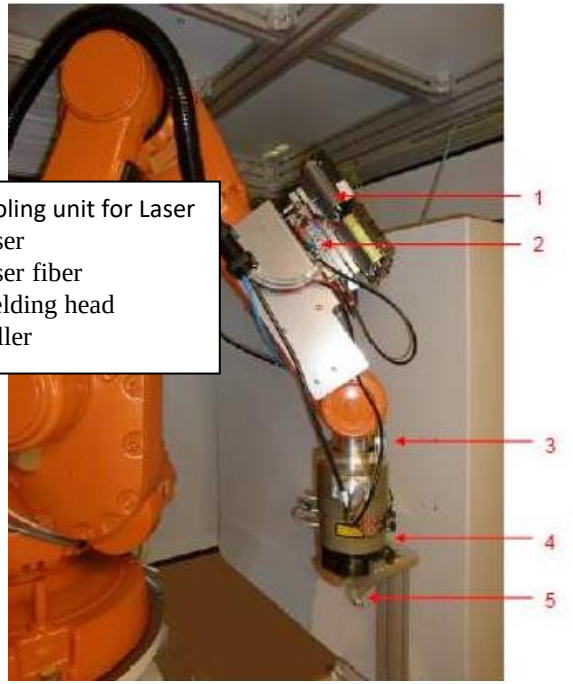


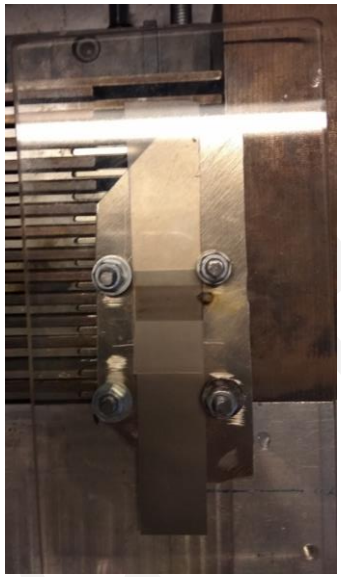
Laser parameters study

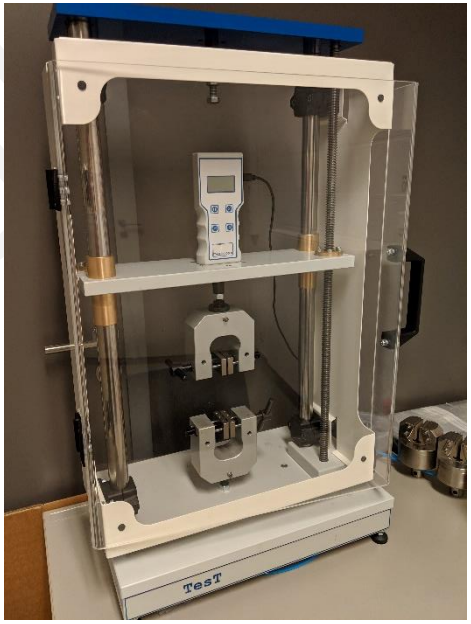
- Power
- Frequency
- Speed
- …
- Aspect ratio : depth/width



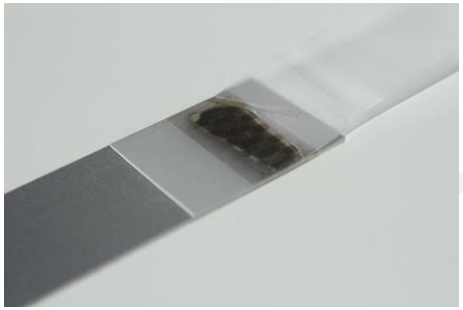
Mechanical test

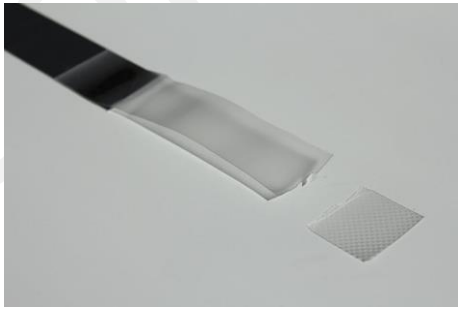




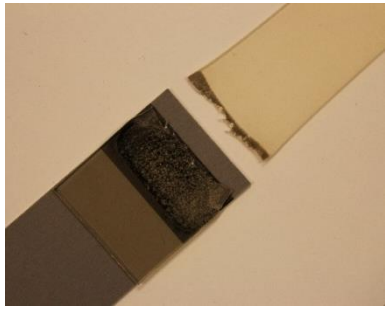


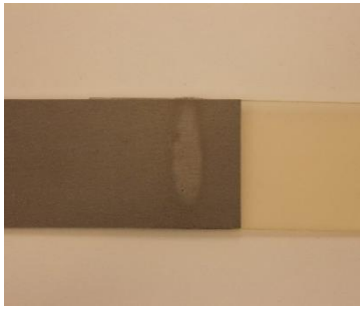
PC



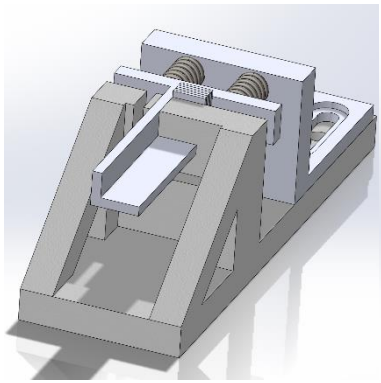


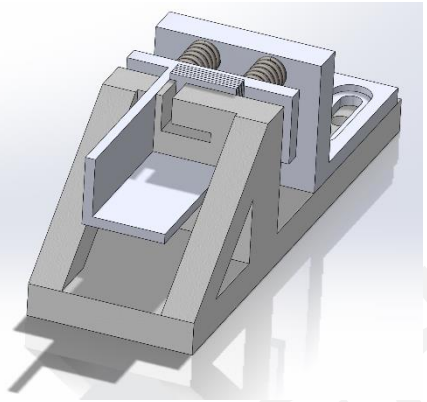
PPSU

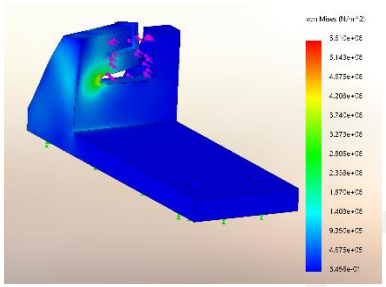


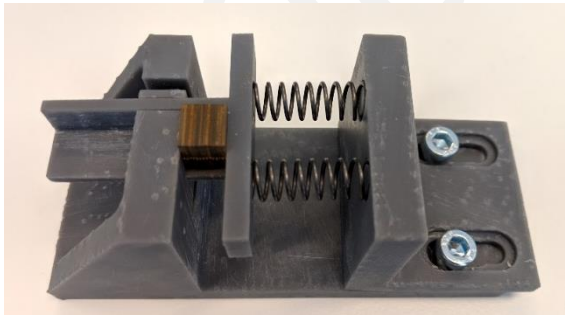


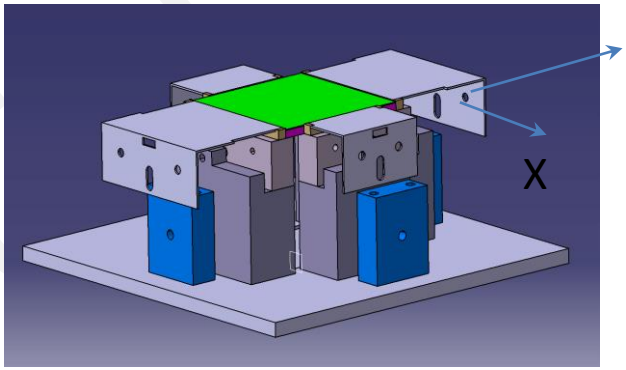
Design and development of clamping tools

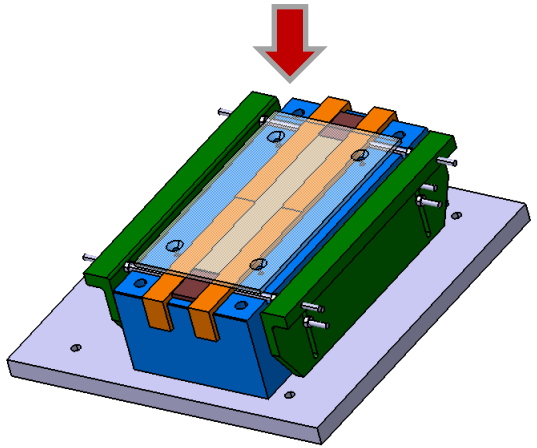




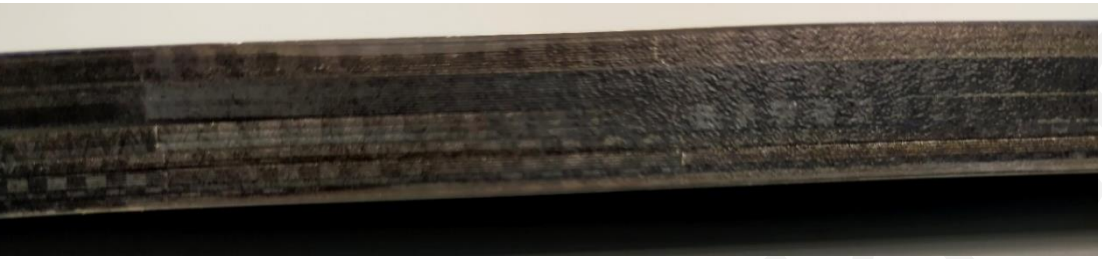








Assemby by using an oven



Advantage:

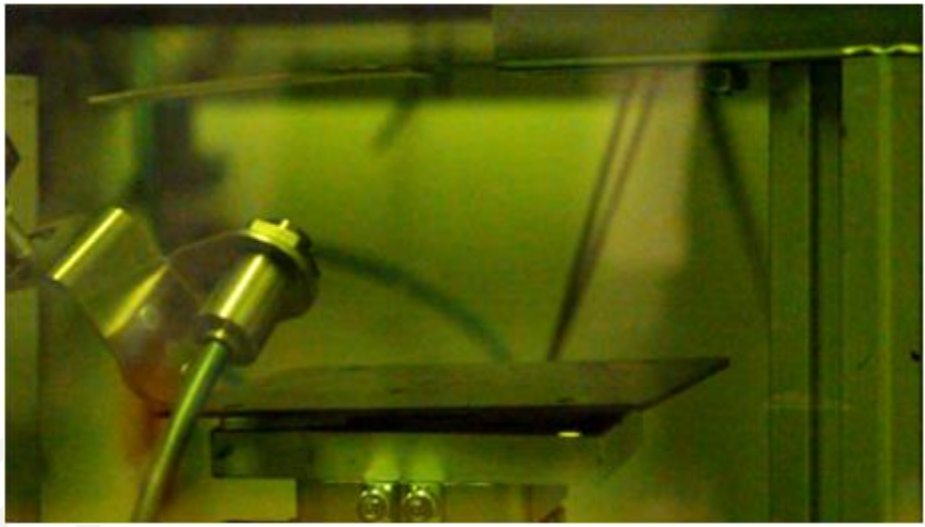
- **Homogeneous** and **slow heating** and **cooling**
- **It reduce** the **thermal stress**

Disadvante:

- It need more energy consumption

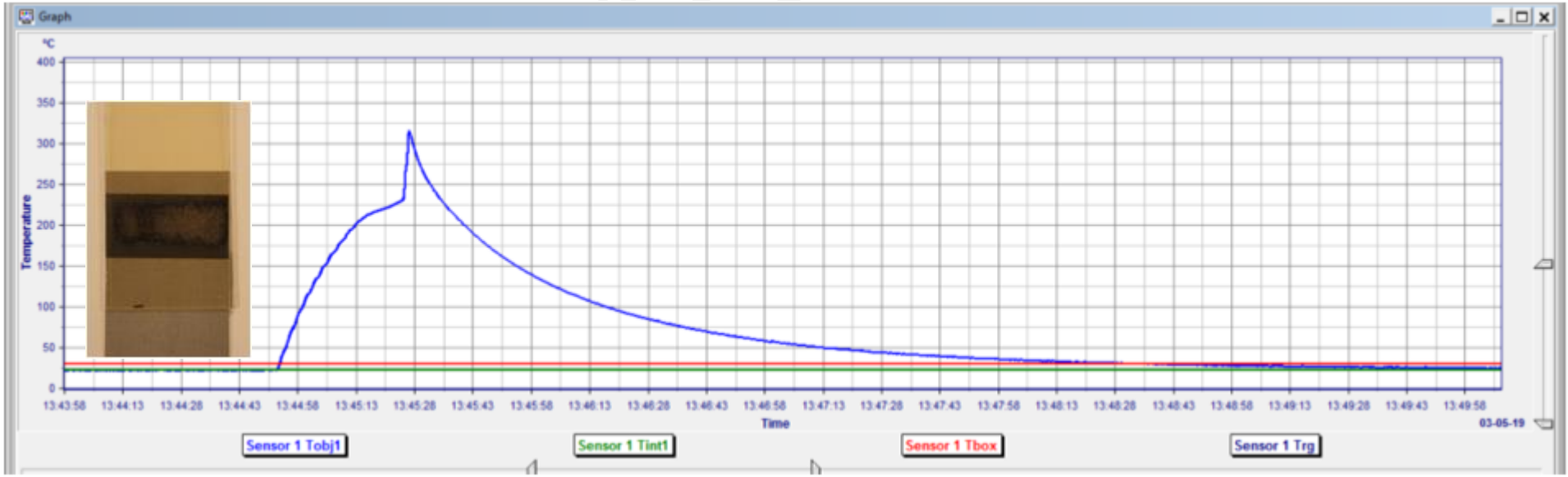
Disamsembly by using laser

Three phases:
- Thetemperature increase
- Heat reaches a saturation point.
- Disassembling
- Easy to disassembly



Advantage:
- Low energy consumption process
- Low labor cost

Disadvantage:
- High equipment cost
- Complex process



Disassembly by using heat gun

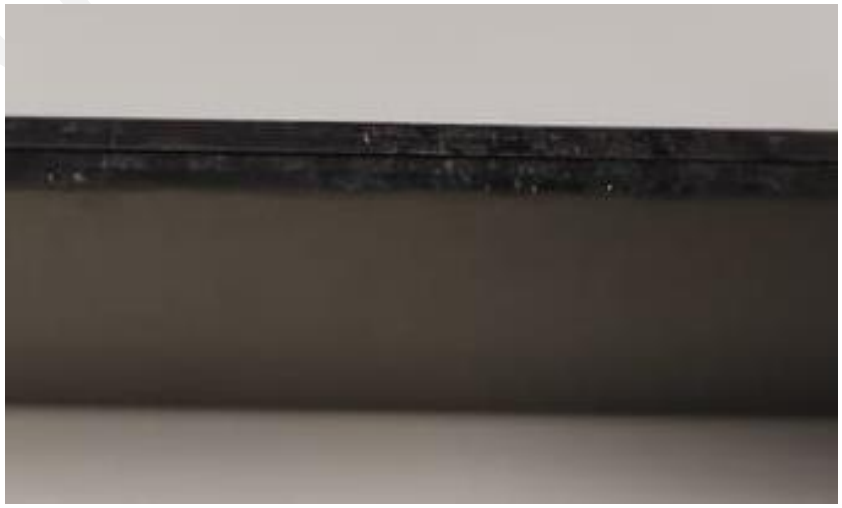
Process: applying heat, starting from 150º and increasing to 350º during about one minute and taking this off with pliers.

Advantage:

- Easy to disassembly
- No high energy consumption
- No high equipment cost.

Disadvantage:

- It need more labour cost



Disassembly by using an oven

Process: Applying heat to 160° during about five minutes and taking this off with pliers.

Adavntage:

- Easy to disassembly
- Low labor cost
- Low equipment cost

Disadvantage:

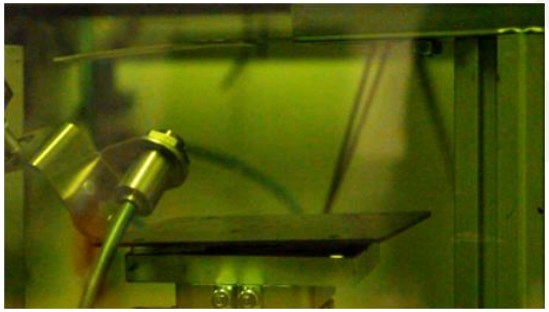
- High energy consumption

Disassembly conclusion

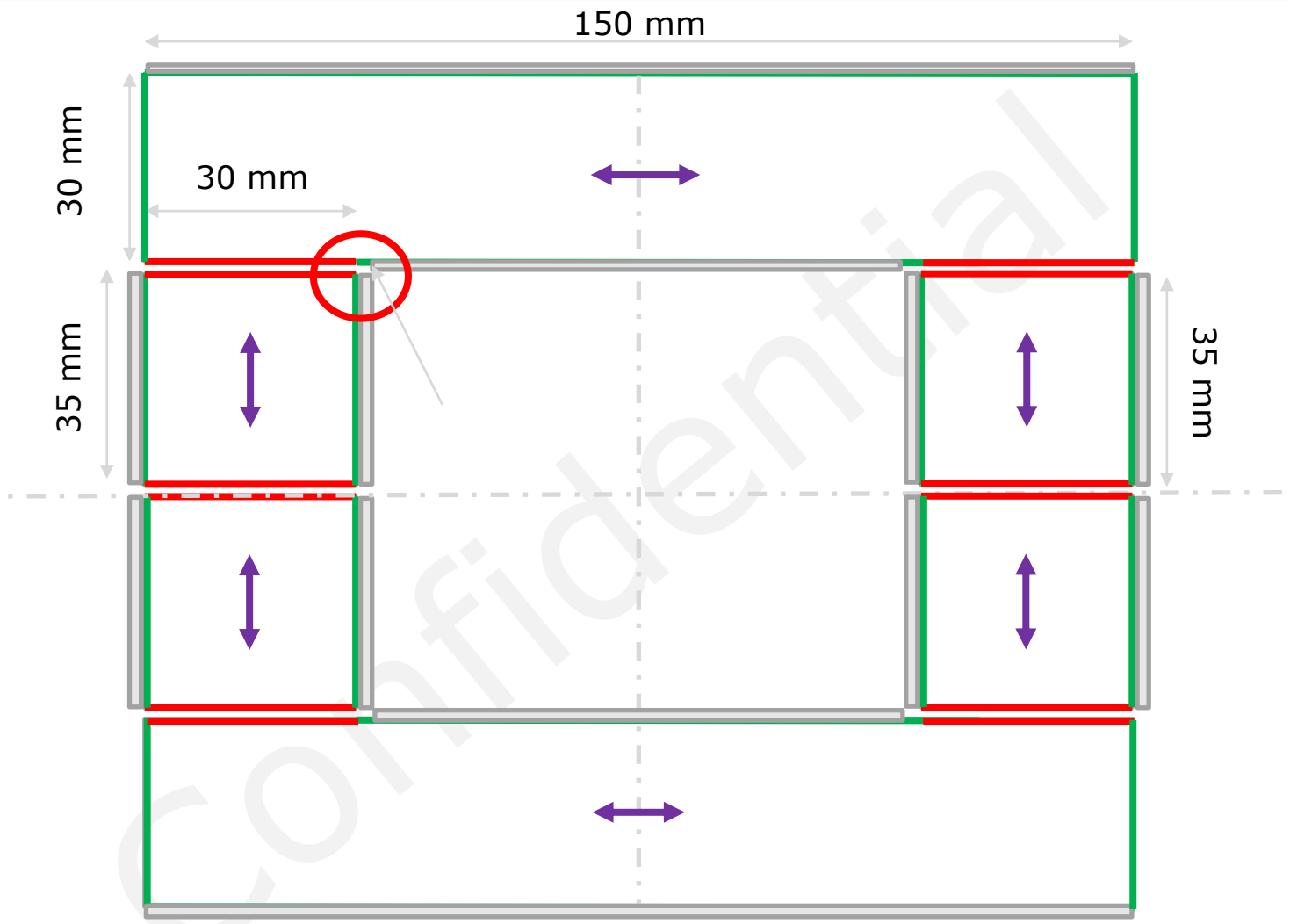
•It was found that after applying a temperature over the vicat temperature the plastic detaches from the metal and the final weight of plastic was 99.5% of the initial plastic weight in all cases.

•From an **energy** point of view, it will be more efficient to use a **laser**. It invests less energy, because heat is focus on the joining.

•From an **economical** point of view, heat gun would be cheaper. Although it need more **labour** cost, **equipment** cost is much lower and **energy** cost is not too high.



DC choke drawing for microtexturizaion and assembly

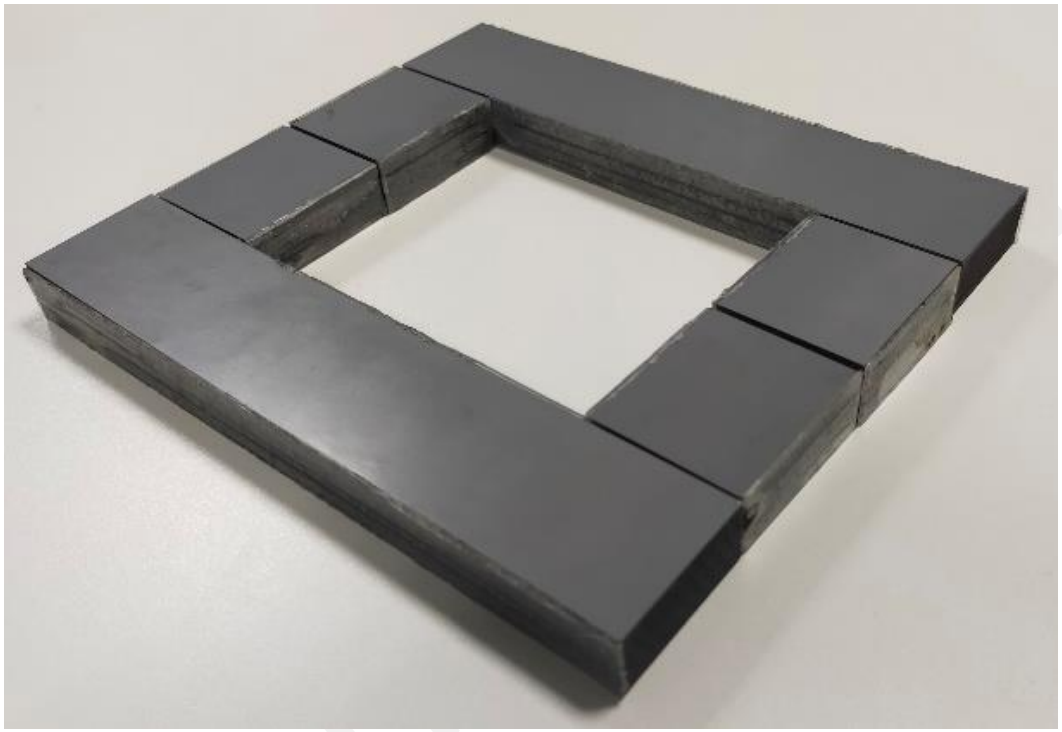


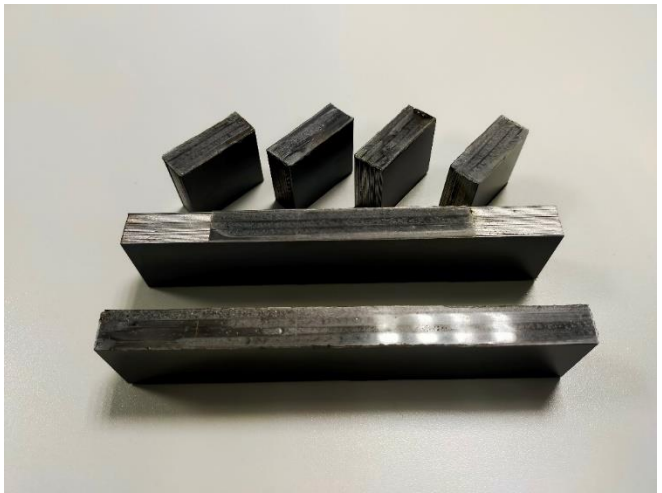
Texturization forbidden

Edges available for texturization

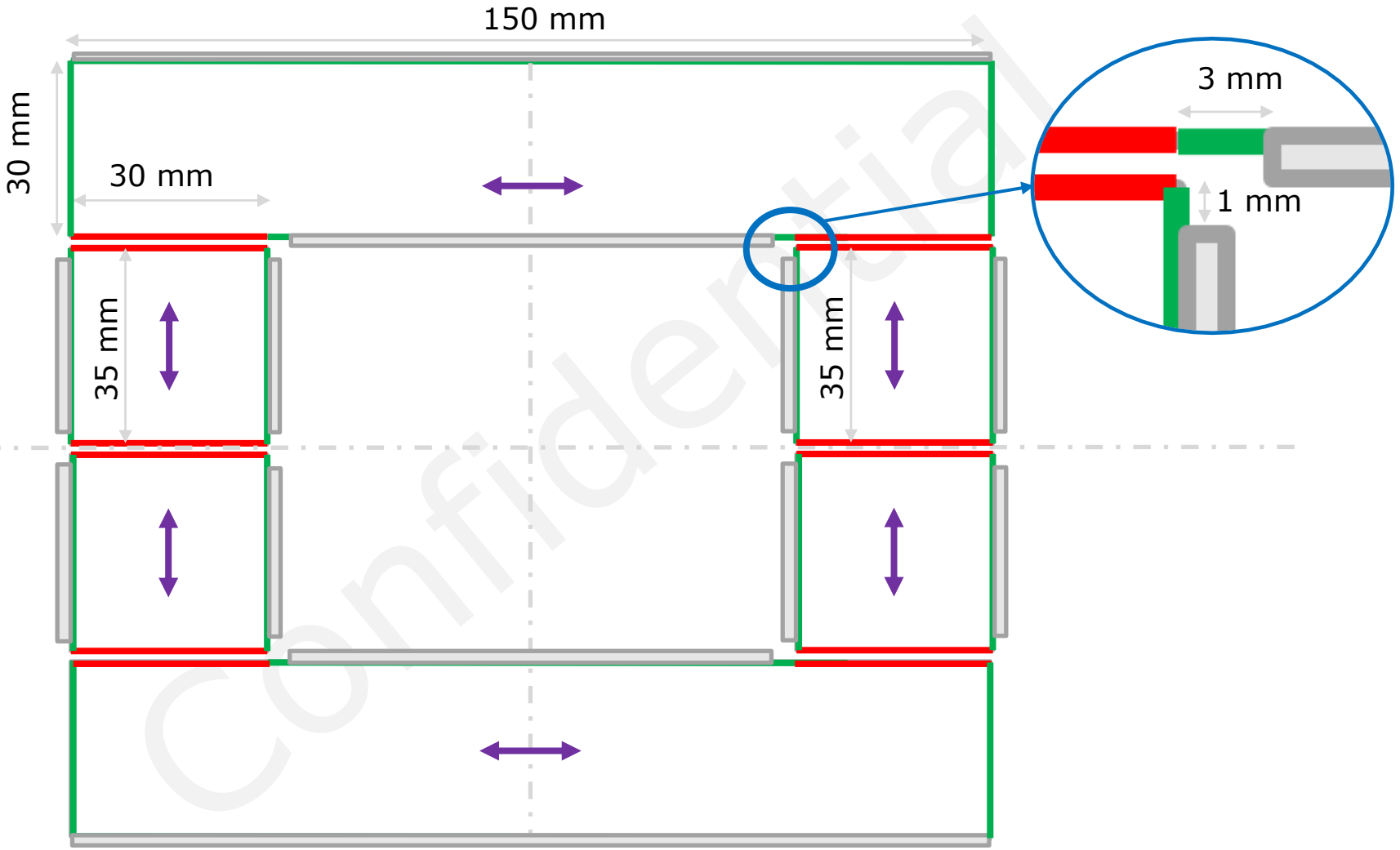
Rolling direction

DC choke manufacuture by using laser welding

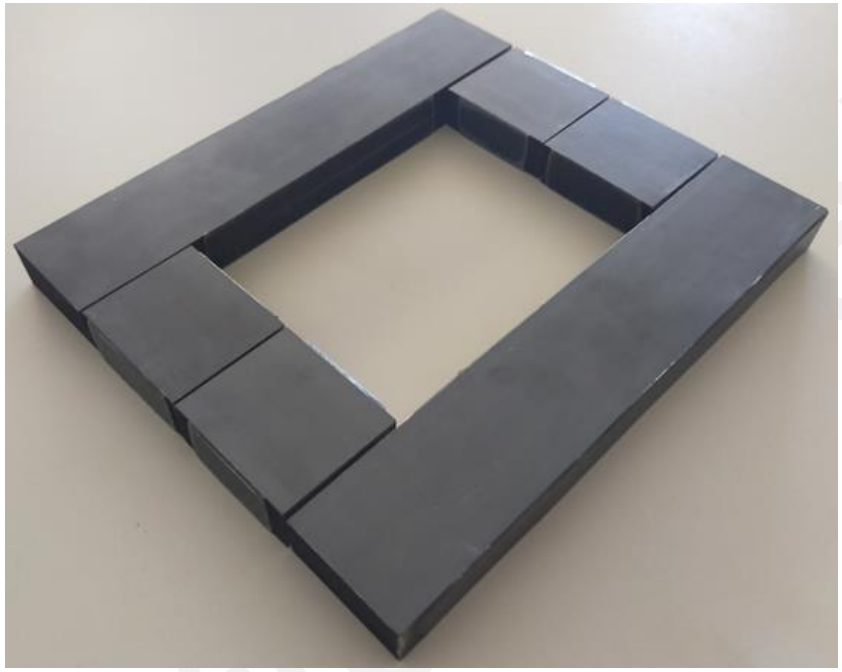


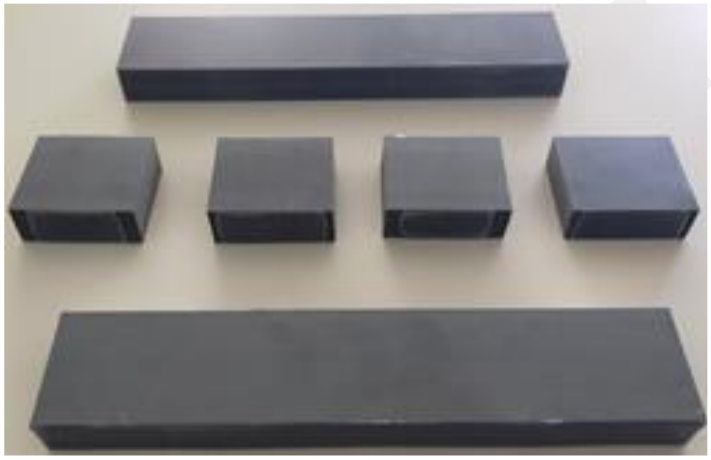


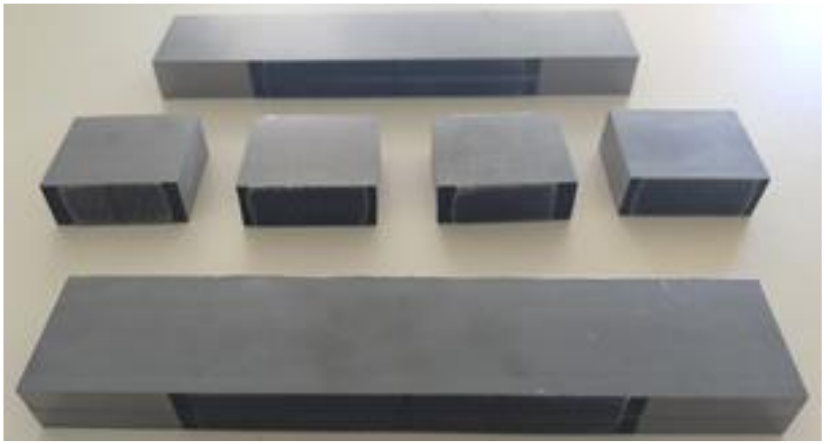
DC choke drawing for microtexturizaiont and assembly



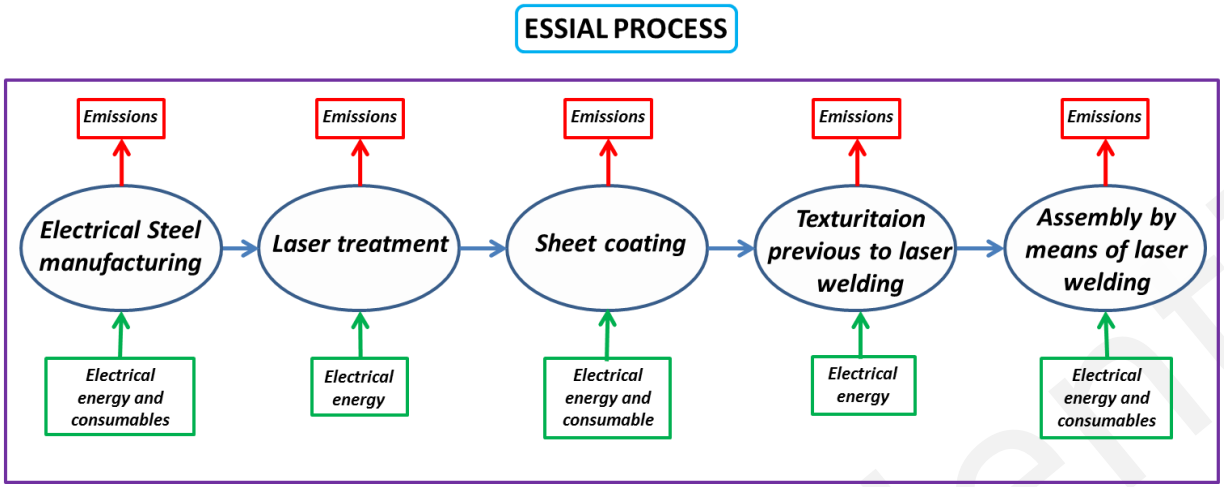
DC choke manufacuture by using an oven





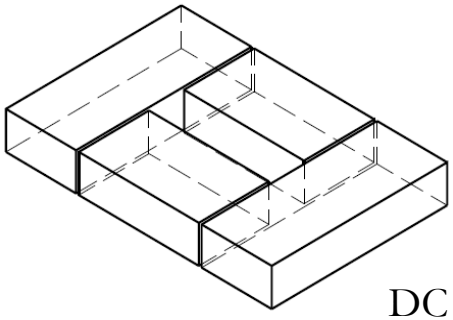


LCA goal and scope definition

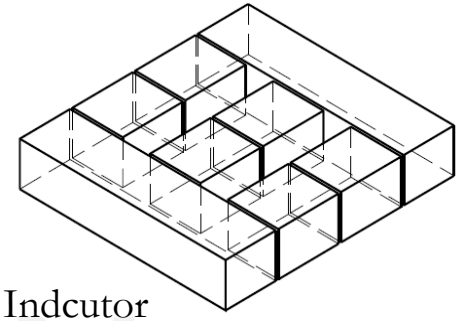


- Analysis from the environmental point of view, the ESSIAL innovations.
- 3 Functional unit
- Cradle to the grave analysis
- Europe as geographical border

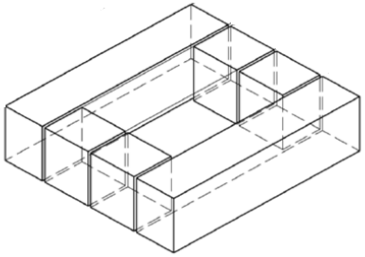
AC inductor 1 phase

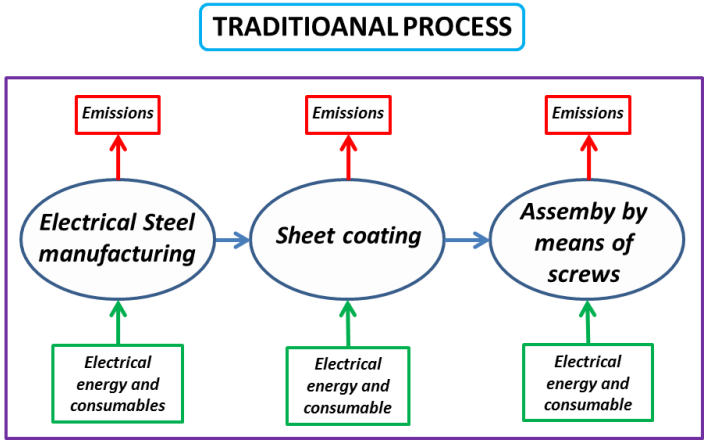


AC inductor 3 phase

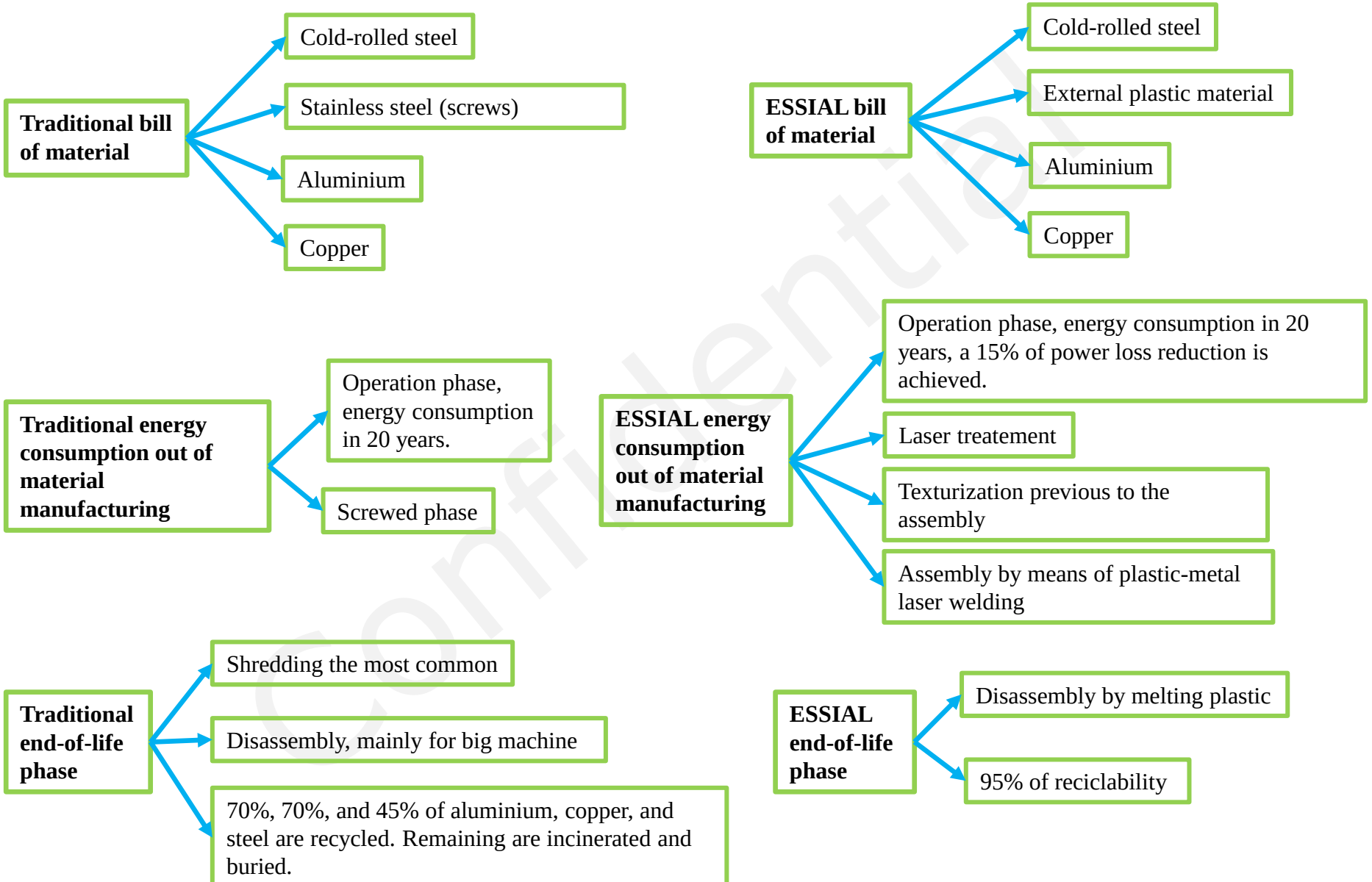


DC Indcutor

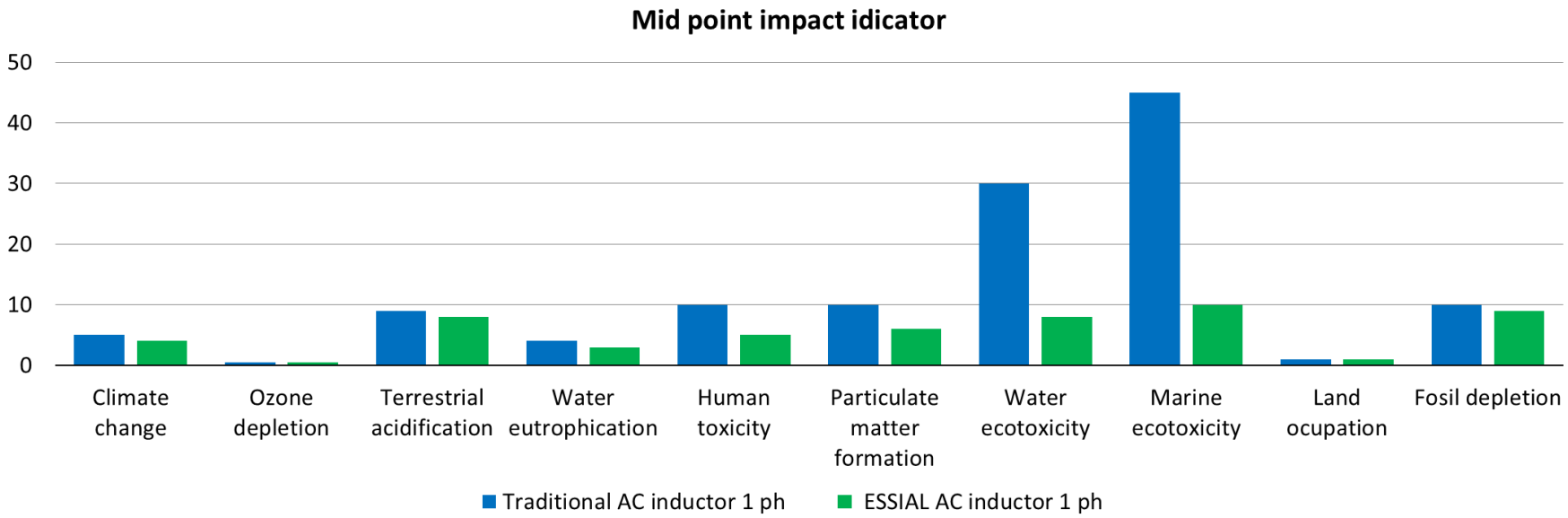




Life cycle inventory (LCI)

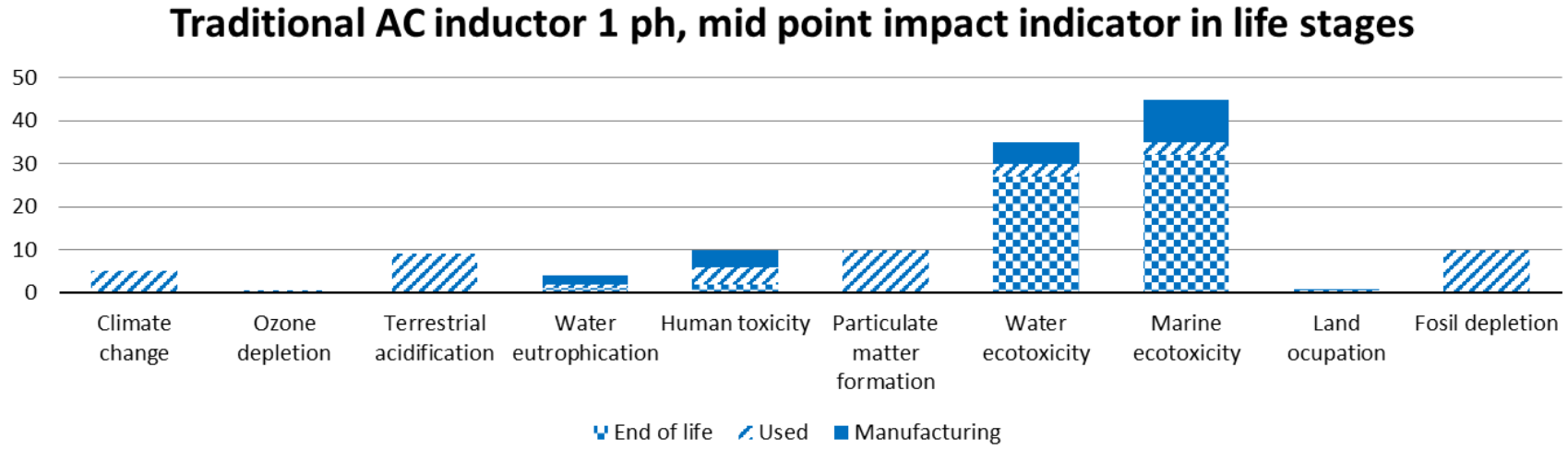


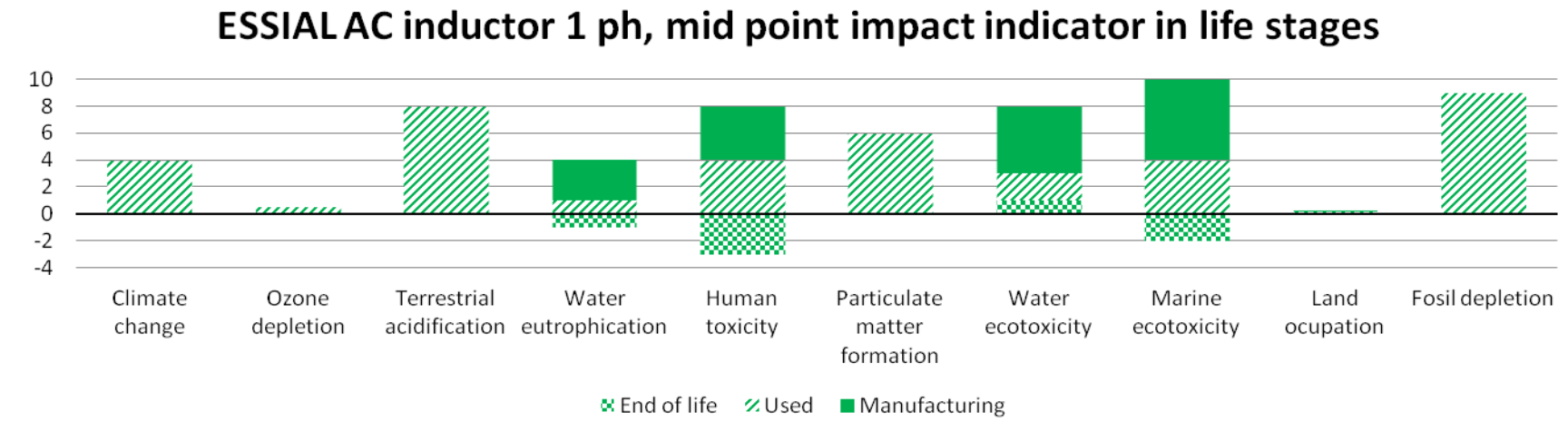
Mid point impact indicator for AC inductor 1 ph



- All indicator are higher in traditional AC inductor 1 ph than ESSIAL AC inductor 1 ph
- A higher difference is observed in freshwater and marine ecotoxicity, due to the difference in end of life strategy as we will demonstrate following
- Excluding long-term emission (more than 100 years) water and marine ecotoxicity are reduced to values below 1
- Between 1-75% improvement is observed depending on the impact indicator
- Impact of some indicator is negligible
- Recipe 2016, SimaPro and EcoInvent database were used.

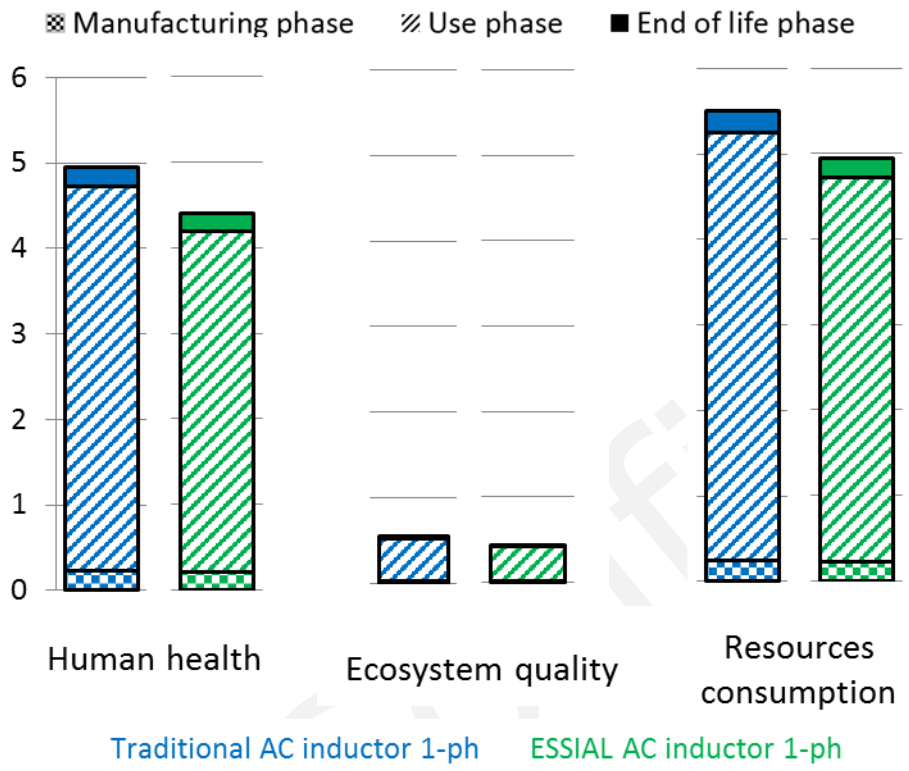
Mid point impact indicator for AC inductor 1 ph in all life phses





- The huge impact in freshwater and marine ecotoxicity for the traditional came mainly from the end of life.
- End of life reduce impact in some ESSIAL indicator. Due to 45-70% of recyclability for traditional and 95% for ESSIAL.
- Manufacturing phase is more representative in ESSIAL than in traditional
- Used phase is high in a lot indicators, due to energy consumption in this phase.

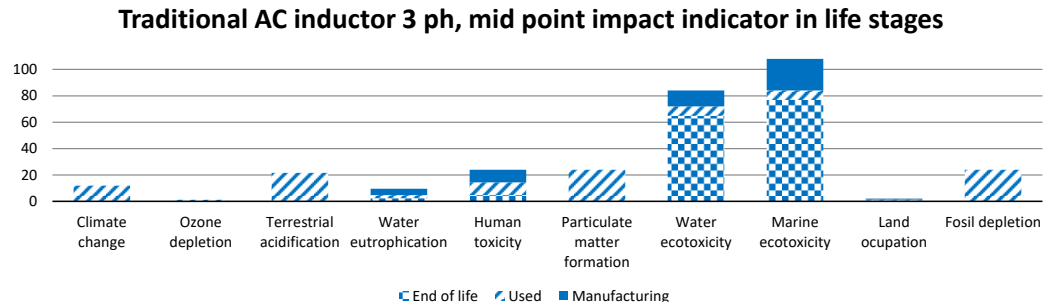
Global impact categories for AC inductor 1-ph

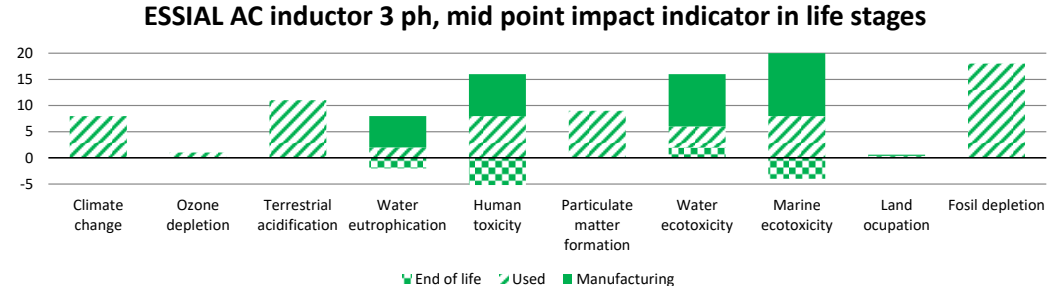


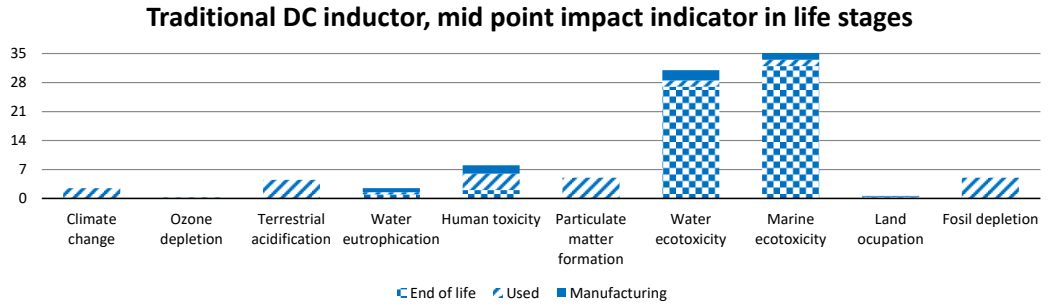
- Climate change and ozone depletion represent human healt.
- Fossil depletion and land ocupaiton represent resource consumption.
- Rest of indicator represent ecosystem quality category
- The lower value for midpoint to endpoint conversion factor of Recipe methology, is the consequence of lower values for the ecosystem quality.

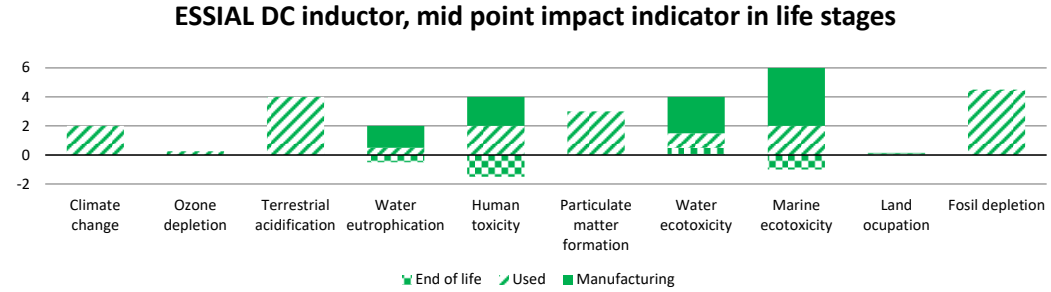
  Results are ruled by the used phase, and so because energy consumption.
- Manufacturing and end of life phase represent less than 10% of the impact
- Overall impact reduction around 10 % with ESSIAL

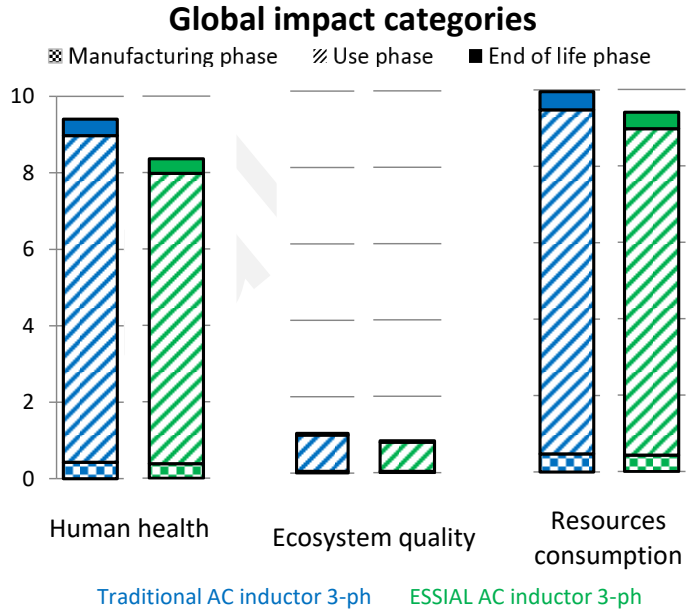
Mid point impact indicator in all life phases and global impact categories for AC inductor 3 ph and DC inductor

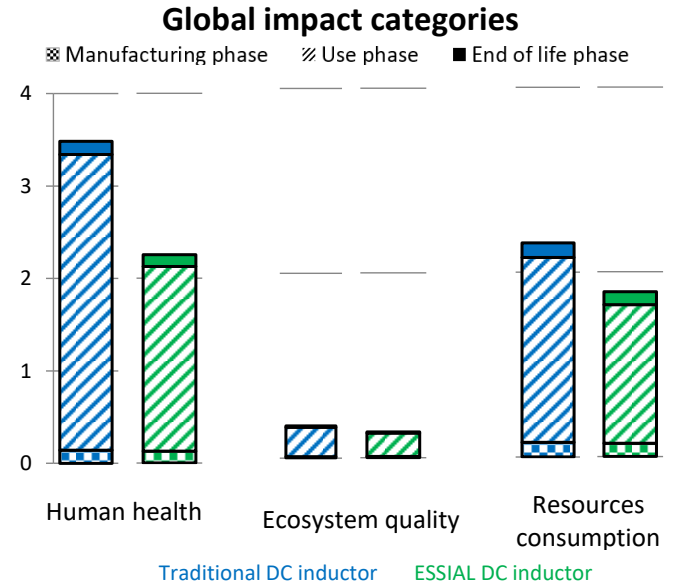












LCC functionalization of metal surfaces

- The best result is observed, with a laser power of 300 W. Although you increase the investment cost you decreease energy consumption.
- In best cases (300 W) the ROI is between 4.5 and 6.3 year

AC inductor 1 phase	
ROI for laser treatment with power between 1-3 w (year)	309,43
ROI for laser treatment with power between 10-30 w (year)	3,42
ROI for laser treatment with power between 100-300 w (year)	**4,71**
AC inductor 3 phase	
ROI for laser treatment with power between 1-3 w (year)	416,27
ROI for laser treatment with power between 10-30 w (year)	43,59
ROI for laser treatment with power between 100-300 w (year)	**6,32**
AC transformer 3 phase	
ROI for laser treatment with power between 1-3 w (year)	316,83
ROI for laser treatment with power between 10-30 w (year)	33,18
ROI for laser treatment with power between 100-300 w (year)	**4,82**
AC transformer 1 phase	
ROI for laser treatment with power between 1-3 w (year)	297,03
ROI for laser treatment with power between 10-30 w (year)	31,12
ROI for laser treatment with power between 100-300 w (year)	**4,53**

LCC assembly process

- ROI for 1 phase, 3 phase and DC inductors are 5, 9 and 1 years respectively
- The ROI is dependant maninly of the texturization
- Possibility of reducing the texturization time even more by reducing the texturization area or by increasing the laser speed of this process
- Other advantages: avoiding short circuits, reduce vibrations, and ease automation of disassembling and recycling.
- In conclusion, the novel assembly process is profitable in economic term as well as in environmental terms.

Traditional assembly process by using screws cost (€)	
AC Inductor 1 ph	1,67
AC Inductor 3 ph	5,00
DC inductor	1,67
Microextructuration process cost (€)	
AC Inductor 1 ph	53,02
AC Inductor 3 ph	155,77
DC inductor	6,41
Power loss reduction with ESSIAL innovation in 1 year due to the assembly process cost (€)	
AC Inductor 1 ph	13,14
AC Inductor 3 ph	19,71
DC inductor	6,78
Laser welding process cost (€)	
AC Inductor 1 ph	10,13
AC Inductor 3 ph	29,75
DC inductor	1,23

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Thank you for your attention!

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Monday, 11 July 2022 – UniLaSalle, Amiens (France)