# SUSTAINABLE MANURE

**DELIVERABLE**

## *Total unit design ready for manufacturing*

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**Nature[1]: Demonstrator**
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**Work Package: WP3**
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[1]Nature: R = Report, P = Prototype, D = Demonstrator, O = Other, E = Ethics
[2]Dissemination level: PU = Public
PP = Restricted to other programme participants (including the Commission Services)
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# 1. Introduction

## 1.1 Description of work package 3

The objective of work package 3 is to optimize the design of the commercial unit and make it suitable for serial production. This is done by fulfilling the following goals:

- Provide three semi-commercial pilot units for the pilots on the farms (SA)
- Optimize and tune the design, operating system, and performance of the plasma unit according to the results obtained from the pilots carried out in WP4 (SA/N2)
- Adapt the power supply to ensure high robustness energy efficiency (SA)
- Design a system including plasma generator with cost below EUR 50k (SA)
- Design a unit with a maintenance schedule below 3 months (SA)

## 1.2 Description of deliverable 3.2

Deliverable D3.2 aims to design a first-of-a-kind commercial system suitable for serial production. Technical specifications and business requirements to gain market value must be met. The business requirements will be defined upon start of the task and will include unit cost below 50k EUR and maintenance schedule below 3 months. When the first of a kind commercial system has been proven, the actual system will be designed based on the learnings from the first generation.

# 2. Results

## 2.1 Design changes and optimization

The plasma torch and docking station has undergone quite substantial changes during the project. Figure 1 below shows the torch in its original version which was the predecessor to the torch which has now been developed for N2 Applied. In Figure 2 the final MK4.5 version of the torch is shown for comparison.

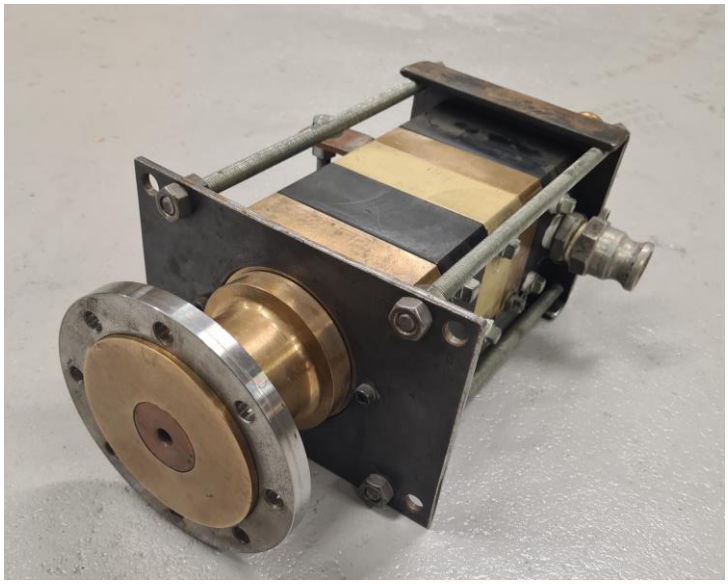


*Figure 1. Original ScanArc plasma torch type 10.*

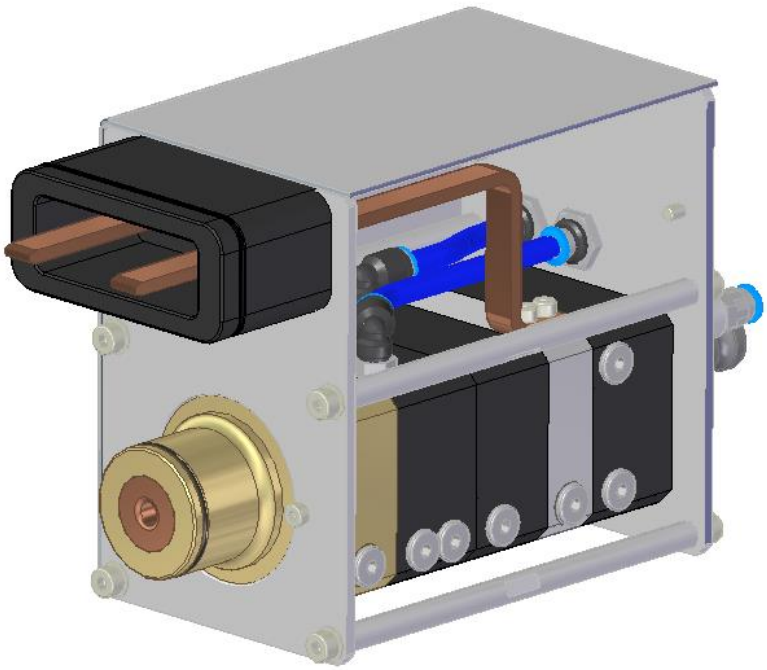


*Figure 2. MK4.5 version of the ScanArc plasma torch.*

As can be seen from the figures above, the nozzle, electrical connections, gas and water connections and hood has all been redesigned among other things. The new version of the torch is easier to manufacture, it integrates with the N2 Applied system and it is significantly safer to operate and handle. The docking station has undergone a few adjustments to accommodate N2 Applied requirements and the MK4.5 version is shown in figure 3. The docking station has been developed with safety as the key aspect. A lock mechanism which can be integrated in the overall N2 Applied safety circuit has also been added.

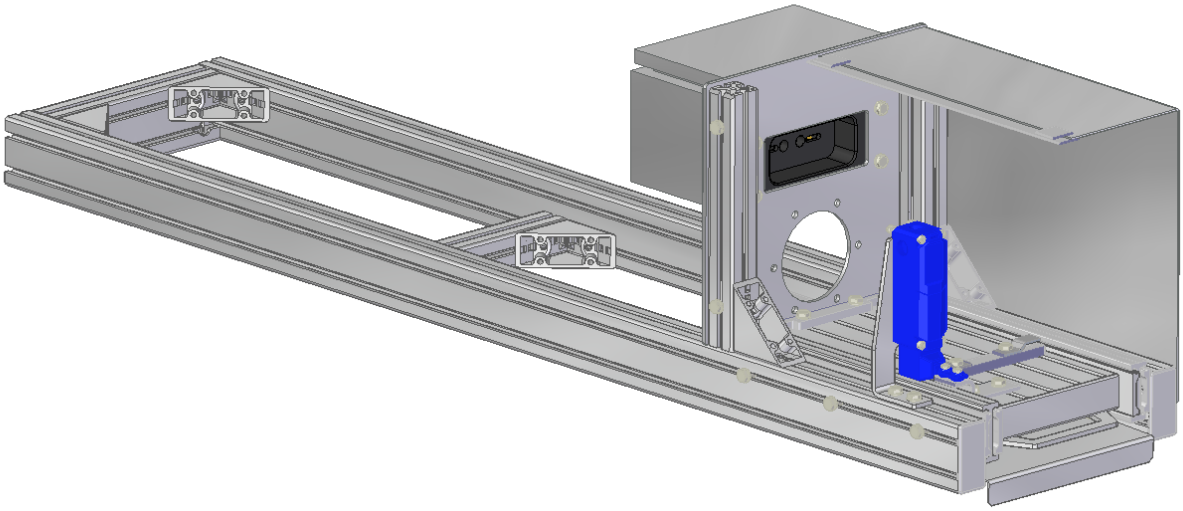


*Figure 3. Final version of the docking station.*

During the first year of the FTI project there was extensive testing of the plasma torch to find an electrode geometry which had the lowest amount of wear during operation at 50 kW. During this period, 22 tests were performed and documented over the course of a few months. The results of the tests were analyzed and yielded a new geometry which has since then been used for all deliveries before version MK4.5 of the plasma torch.

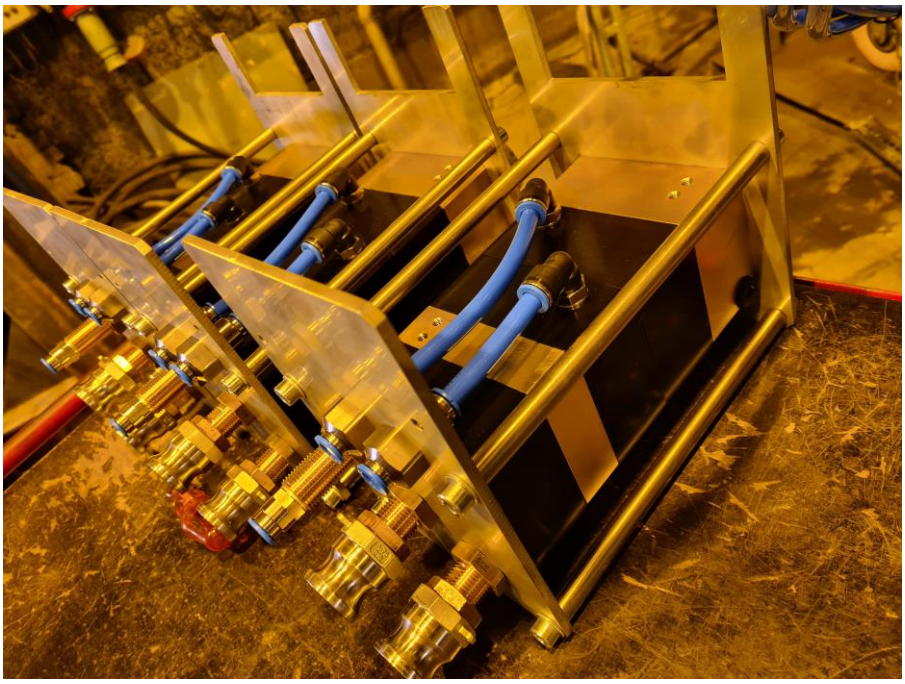


*Figure 4. Plasma torches of the MK4.5 design with triple gas inlets.*

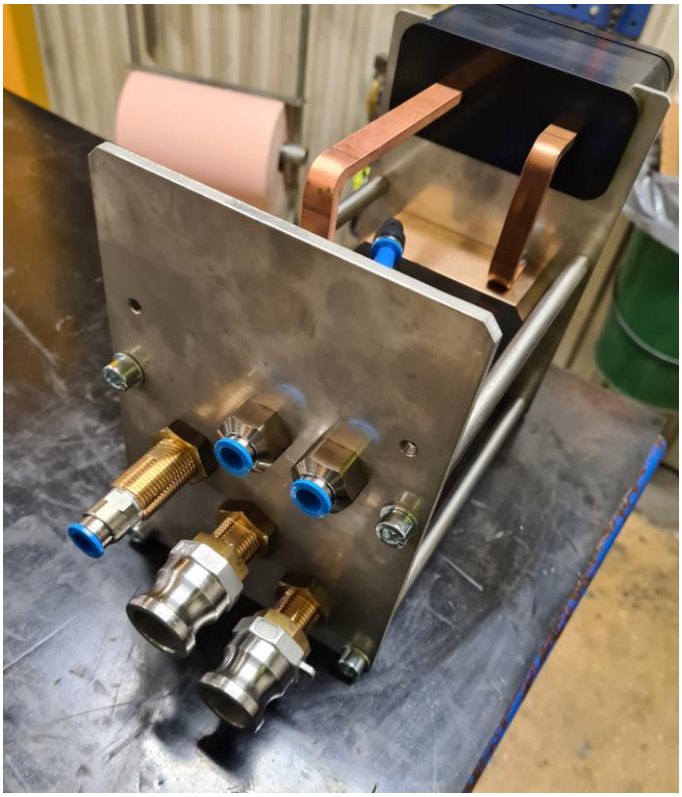


*Figure 5. New Festor connections on MK4.5 torch.*

During the first year of the FTI project, it was identified that one component on the plasma torch was subject to corrosion which was limiting the lifetime of the torch and added to the required maintenance. The corrosion issue was analyzed and as a potential solution a new material selection for that specific component was proposed.

The component was manufactured in stainless steel instead of brass and testing was performed at ScanArc to verify that the performance of the torch was as good as with the previous material. The components were then sent to N2 Applied for long term testing and the results showed that the corrosion was reduced significantly. Drawings has been updated to include the new component in future deliveries.

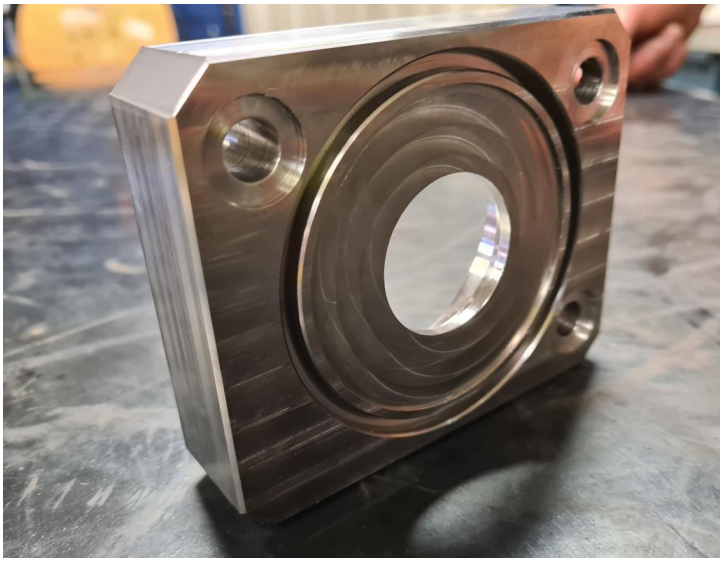


*Figure 6. Component manufactured in stainless steel to reduce corrosion.*

Besides the completed developments, there are also a few theories for increasing the lifetime currently being tested. These tests require extended periods of time before any conclusions can be made. Preliminary results of the tests should be ready before the end of the FTI project.

## 2.2 Cost reduction

To reduce the cost for the plasma system, each of the following components of the system was evaluated:

- Plasma torch
- Docking station
- Power supply

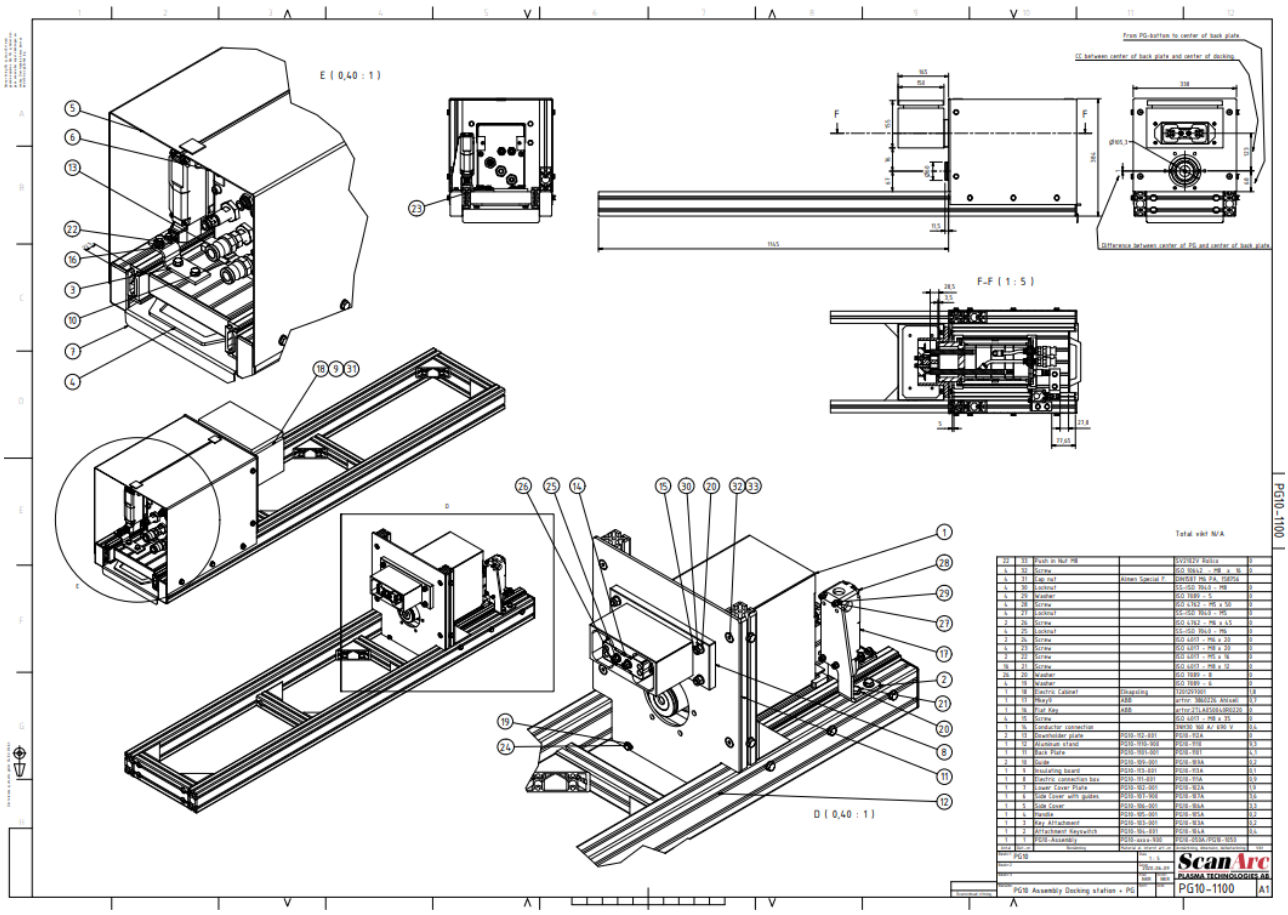
The cost of the plasma torch and docking station is made up of material costs, manufacturing costs and assembly cost. The cost of material is difficult to reduce without having a drastic increase of order volumes. The manufacturing cost was evaluated by comparing new manufacturing sub suppliers and their respective prices for a given order. For small order volumes the largest part of the overall cost for the torch and docking station is the cost for assembly at ScanArc. The plasma torch in its original version required manual adjustments and calibration before it was ready to be assembled and delivered to N2 Applied. To reduce the

number of working hours needed, some design changes and updates to drawings was made to simplify the assembly process and reduce the amount of manual work involved at ScanArc. After the design changes the cost of labor is lower which will be even more important as the order volume increases.

Most of the overall cost for the plasma system is the power supply. To achieve a major decrease of the cost it was decided that a new power supply was to be designed, engineered, and tested by ScanArc. The aim was to develop a power supply with a cost below 30 000 EUR without any decrease in performance. A power supply has been constructed over the course of the past two years. Even though there were several technical challenges as well as supply chain issues for electrical components due to the COVID pandemic, the system is at this point functional. The specific performance of the system is yet to be determined as this requires long term testing. However, the system is operational and ScanArc will deliver the electrical drawings, schematics, and some key components to N2 Applied which provides the conditions to set up a supply chain for the new power supply.

## 3. Drawings

A complete overhaul of the original drawings has been made for the MK4.5 torch update. The updated drawings will likely decrease the number of errors during manufacturing which was previously an issue when producing parts for the plasma torches and docking station. It will also make it easier to find new sub suppliers for manufacturing parts since the new drawings are made according to modern standards and conventions. A 3D model of each part can also be provided for computer-aided design and manufacturing.




## 4. Conclusion

The project has resulted in an improved product which has been adapted to the N2 Applied process and requirements. The lifetime of the plasma torch has been increased and significant progress to reach the goal regarding maintenance interval has been made. The plasma torch and docking station has been optimized and tuned according to the results obtained from the pilots carried out in the project. To achieve a maintenance interval of 3 months or more there needs to be more long-term testing and development.

The plasma system is now a first-of-a-kind commercial system. There has been progress regarding cost reduction and ScanArc has provided the technical development and testing to prove that a cost below 50 000 EUR is possible for the complete plasma system without sacrificing performance.