Workshop on PEMFC Stack and MEA manufacturing: Is the EU industry ready for the challenges?

Key discussion outcomes

Because of stricter regulation on CO2 emission and improvement of air quality the demand for fuel cells (FC) solutions in both the transport and power sectors is expected to increase at an unprecedented rate.

But does the European fuel cells supply chain of stand ready to supply this demand?

On 11 October 2018 around 60 representatives drawn from the whole EU supply chain as well as representatives of research centres met to discuss the state of the art of the PEM fuel cell supply chain in particular and its future challenges.

The EU is competitive on materials, quality techniques and knowledge

The European supply chain for PEM fuel cells ranks well today worldwide in terms of competitiveness. It can count on a strong R&D basis and an increasing number of industrial players with specific competence in the development of all components of fuel cells systems. This applies as well to MEA and stack suppliers. Key elements of today's competitiveness are the **development of materials**, the **strong expertise in quality control techniques** and a well-established **loop of knowledge** between academia/research centres and their industrial counterparts.

If the European FC supply chain is to remain a competitive player, it will need to deliver on 3 key areas**:**

1. **dramatically increased production capacity**,
2. **lower costs** and,
3. raise **quality standards** on pair with other mainstream products.

In order to meet these challenges the European suppliers will need **continued support** for the introduction of innovative and disruptive manufacturing techniques and make substantial investments, which will be enabled by: a strong, clear long term of the **European OEMs** and the development of **local markets** still driven by policy

It is essential that these enabling conditions are realised, because while the EU has solid competitiveness basis on which to build without continuous investments in innovation it could lose ground rapidly.

But the EU position is challenged at the export and internal markets, it must react immediately

The prospects for a rapid growth of demand of PEMFC in the near future (until 2025) are strong. The European Union, the US (California in particular), Japan and China combined interest in supporting the use of FCEVs in particular could lead to an **unprecedented demand** for PEM fuel cells in a relatively short time span[1].

[1] It is estimated that PEM FC deployed today amount to around 1.3 GW. Combining the aspirational targets of EU, US (California), Japan and China the demand could grow to up to 43 GW by 2025.

The EU leadership will be put under pressure in its export markets in the near future by other regions of the world where fuel cells technologies are a strong reality already today and other regions where substantial investments are expected to develop both local markets and supply chain.

The strongest demand is expected to come from the transport (road sector) where large fleets of zero emission vehicles (ZEVs) will be deployed to face the double change of lowering greenhouse gas emissions and eliminating pollutants. While part of these fleets will be composed by battery-only vehicles, FCEVs and hybrid solutions (battery & fuel cells) are also expected to grow rapidly.

This however, does not mean that automatically the European PEMFC supply chain will benefit from these developments; even if such developments should materialise in Europe. The recent examples of 1.000 trucks in Switzerland or the 5.000 cars for the French market to be delivered by an Asian supplier well illustrates this point.

The challenge: "produce quantities at quality for reasonable costs"

Supplying future markets entails ramping up the production of few hundreds of units per years to hundreds of thousands and even millions. As an example, the production of 100.000 FCEVs in a year would mean producing 400 million MEAs[2]. All this while ensuring very stringent quality standards (1 defective part per million). These numbers alone give an idea of the magnitude of the challenge ahead. While 100.000 vehicles do not represent by OEM standards an impressive number (70 million cars were produced in 2016), manufacturing such number of FC systems and sub-components does represent a challenge for the whole sector.

Out of the comfort zone: sector mingling and technological disruptions are indispensable

In this sense, the involvement of the OEM in the ongoing research and innovation activities represents good news for the PEM FC sector and an important alliance to overcome the "quantity at quality" challenge.

Other mingling with pharmaceutical industry (quality and white room process) and microelectronics industry (processes) would as well allow the PEM FC suppliers to learn **manufacturing and quality control techniques from more mature and established sectors.**

This is aspect is key; the innovation and improvement of the manufacturing processes currently adopted within the sector are not likely to deliver on the volumes needed in the coming years. The introduction of **disruptive techniques** is needed to avoid that the manufacturing capacity of the industry becomes a limiting factor to the technology uptake.

OEM and public funding can de-risk the required long-term investments

The introduction of innovative or disruptive techniques in manufacturing represents a capital intensive and time-consuming activity with high risks embedded. As noted by the participants the **public support** provided by the FCH JU in this domain is vital. However, on the long run, this needs to be coupled by a tangible commitment of the EU OEMs toward the commercial adoption of the FC technologies as one of the near-future mainstream alternative powertrains.

The stated openness of the OEMs to purchase systems or components from EU suppliers rather than by default producing all in-house and more in general the positive market outlooks represent a step in the good direction. In order to unlock the investments needed and ensure ROI, however, the EU PEM FC manufacturer need a **long-term purchase contracts.** Too much hesitation could lead the EU manufacturing base to lose its competitiveness edge to other regions of the world (i.e. China) who are strongly developing their markets and manufacturing base.

Axes of research and manufacturing improvements: faster, better, cheaper

[2] Assuming 400 MEA per stack per vehicle

Cooperation with the final customers and investments will be needed to overcome a number of key technical challenges. The main ones discussed at the workshop include:

- **Design for manufacturability.**
  The components of a PEMFC systems are complex niche products. In the past most of the research efforts focused on the performance improvements of these components. While these activities granted good results in terms of performance, cost and durability of MEA, stack and BoP components; their manufacturability has not improved at the same path. It is important now to simplifythe design of each component, reduce its parts and replace materials not compatible with rapid serial production.
  A similar focus will be required in order to simplify the architecture of the FC systems. Key to this goal are the improvement of the interfaces among different components and a **holistic approach**, which will be made possible only by a strong cooperating among the different suppliers.

- **Understanding of the manufacturing processes**
  Adopting a holistic approach implies being able to define the optimal balance between performance and cost of the components. This is no easy task considering the wide range of possible configurations available and the fact that there is not yet an in-depth understanding of the production costs.
  Further efforts need to go in gathering data and creating models; the concrete results will be tools that, based on real life cost data, will enable the system designer to define the optimal solution. At this regards the activities of the INN-BALANCE project are particularly promising.

- **Optimisation of the assembly process**
  A simplification of components design and architecture will have ripple effects throughout the manufacturing and assembly processes. A smaller number of parts, in fact, will enable a **reduction of assembly steps** and the introduction of greater levels of **automation** with beneficial effects on costs and yields. The development of production lines, however should take into account as well the concepts of **modularity and scalability**. This is important in view of the expected fluctuations of the market. DIGIMAN, INLINE and Fit4Amanda are projects exploring these themes.

- **Development of materials**
  Another avenue to keep exploring to obtain reduction of manufacturing costs is represented by the development of materials. The specific goals to pursue are the **replacement of expensive materials**, being able to produce on industrial scale active materials, develop manufacturing processes **eliminating material waste** and novel handling techniques **for non-rigid materials**. This is an important aspect to nurture as it represents one of the competitiveness edges of the EU. Projects such as VOLUMETRIQ and MAMA MEA will provide important input in this domain.

- **Quality for zero defect products**
  One of the challenges faced by industry today is the categorisation of defects. There are still difficulties today in **distinguishing simple irregularities**, which can be tolerated as they have no consequences on the lifetime and performance of components, **from actual defects**. Classifying as defect what is a simple non-homogeneity item will lead to scraping functioning components or batches of active materials generating higher costs. On the other hand delivering actual defective components to the final customers is not an option either. The development **of inline QC techniques** along with adapted hardware and the digitization of

large amount of characterised manufacturing data combined with **“big data**” techniques are considered a promising solution to the problem. The achievement of higher manufacturing readiness levels, a broader use of automated lines granting lower error rates will also allow the industry to switch from a 100% end of line testing, to **testing of samples**. This shift will contribute to lower costs and increased yields. Destructive QC techniques, finally, will also need to be replaced.