

## Next Steps

With only 9 months left until the project end, the next steps are tightly timed. With regard to stack hardware, the new NM12 bipolar plates will be manufactured and validated. Sufficient parts of the validated CCM construction will be manufactured at JMFC and short and full stacks assembled and tested, and the costs analysis initiated. VOLUMETRIQ is on track to achieve a leading stack power density of 4.1-5.0 kW/litre (without housing) and its objective of developing a European supply chain for PEM fuel cell stacks and their key components with high volume manufacturing methods and embedded quality control in manufacture and assembly.

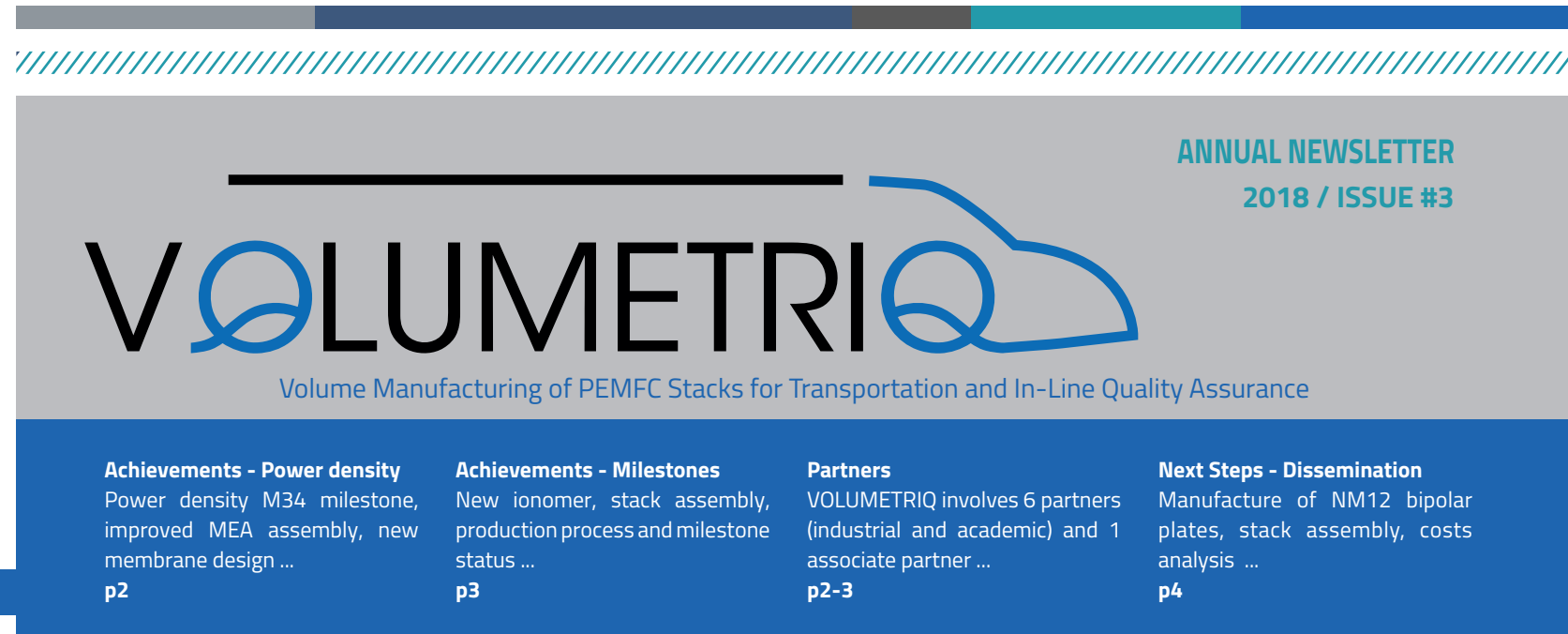
## Dissemination

VOLUMETRIQ presented its results during:

- **ELEN2018**, 13-15 June 2018, Montpellier France  
Functional electrospun nanofibre scaffolds for PEM fuel cell membranes with enhanced mechanical and chemical stability, M. Zatoń, N. Donzel, L. Maldonado, S. Cavaliere, J. Rozière, D. J. Jones
- **GRC Fuel Cells conference**, 29 July-3 August 2018, Smithfield, RI, USA  
Hierarchically Organized Nanofiber/Scavenger Consolidated PFSA Membranes, M. Zatoń, N. Donzel, S. Cavaliere, J. Rozière, D. J. Jones, L. Merlo, C. Oldani, J. Bobolecki, W. Turner, S. Buche

Two manuscripts were published:

- **Design of Heterogeneities and Interfaces with Nanofibres in Fuel Cell Membranes**, M. Zatoń, S. Cavaliere, D. J. Jones, J. Rozière, *Handbook of Nanofibers*, pp 1-37, 2017
- **New perfluorinated ionomer with improved oxygen permeability for application in cathode PEM-FC**, A. Rolfi, C. Oldani, L. Merlo, D. Facchi, R. Ruffo, *Journal of Power Sources* 396 (2018) 95–101



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# VOLUMETRIQ

Volume Manufacturing of PEMFC Stacks for Transportation and In-Line Quality Assurance

<b>Achievements - Power density</b> Power density M34 milestone, improved MEA assembly, new membrane design ... p2	<b>Achievements - Milestones</b> New ionomer, stack assembly, production process and milestone status ... p3	<b>Partners</b> VOLUMETRIQ involves 6 partners (industrial and academic) and 1 associate partner ... p2-3	<b>Next Steps - Dissemination</b> Manufacture of NM12 bipolar plates, stack assembly, costs analysis ... p4
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## VOLUMETRIQ third year Achievement of the power density milestone

VOLUMETRIQ has continued its progress throughout its various work packages during the third project year, with the highlight of the most recent period being the achievement of its Month 34 power density milestone. In testing at ElringKlinger, VOLUMETRIQ catalyst coated membranes fabricated at JMFC using Solvay's Aquivion ionomer, are reproducibly achieving single cell performance of more than 2.58 A/cm<sup>2</sup> at 0.6 V under the project's challenging operation conditions of 80 °C, 50/30% relative humidity at anode/cathode, 2.5 bars absolute pressure.

This validates the current CCM design for manufacture at JMFC of parts for short and full stacks for assembly at EK in their new NM12 stack hardware.

- Power density milestone at M34 achieved
- Improved MEA assembly process leading to a cycle time reduction of ca. 72%
- New membrane design with lower hydrogen and oxygen crossover, improved mechanical properties and similar proton resistance as ePTFE reinforced membranes

Improvements both in components and their assembly have led to the step-change from the M18 milestone point of 2 A/cm<sup>2</sup> at 0.6 V under the same operation conditions, however, a novel catalyst layer construction for high current density performance is also a major contributing factor.



Joint research unit with Montpellier University, leading research organisation in novel approaches to proton conducting membrane development since 1990.

**JM Johnson Matthey** Developer, manufacturer and supplier of membrane electrode assemblies and their sub components to fuel cell stack and system developers worldwide, for over 40 years.

**SOLVAY** leading chemical company working in the fuel cell arena for 15 years, focused on special polymers with application in the hydrogen & fuel cell industry, including Aquivion® PFSA.



An automotive company that has been pioneering hydrogen powered vehicles for more than 35 years.



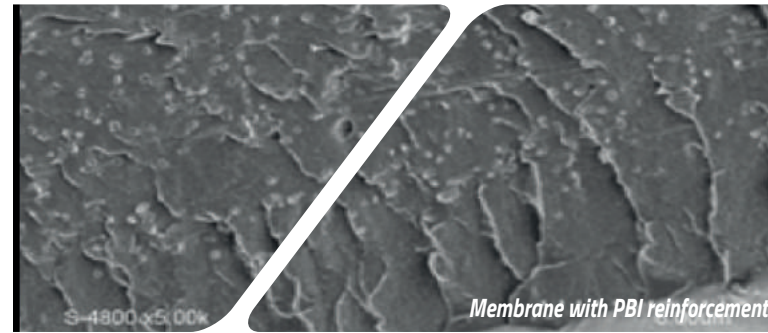
Tier 1 metallic bipolar plate supplier for the automotive fuel cell industry, with experience in developing processes and manufacturing of components for fuel cell stacks for almost 15 years.



Since 2007, SME devoted to facilitating and improving information sharing, communication and dissemination between partners and communication towards the public.



Automotive company, developing fuel cell electric vehicles and components since 1991, with more than 250 FCEVs and 50 buses which have operated successfully since 2004 in customers hands.

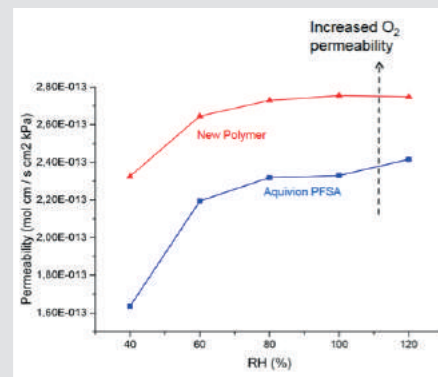
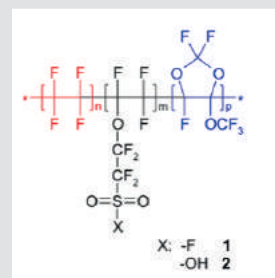


## Achievements and Output

### New ionomer for cathode catalyst layer

In WP3, Solvay has developed the synthesis and characterisation of a new ionomer with improved oxygen permeability specifically designed for the cathode catalyst layer. This new ionomer incorporates a dioxole functionality designed to introduce amorphous character into the Aquivion PFSA structure, and increase oxygen permeability. The new ionomer has higher oxygen permeability than Aquivion over all relative humidities, and leads to a performance gain at high current density in both dry and wet operating conditions.

These findings were recently published in J. Power Sources **2018**, 396, 95-101.

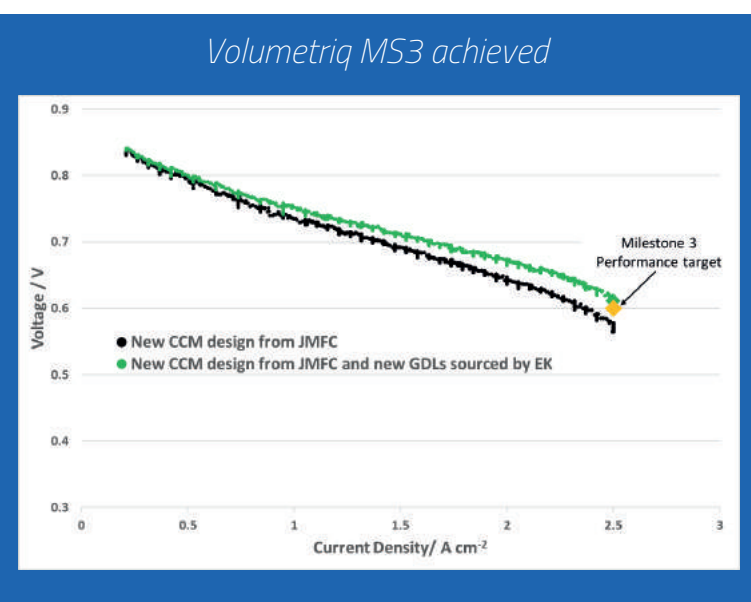


### Achievement of the power density milestone

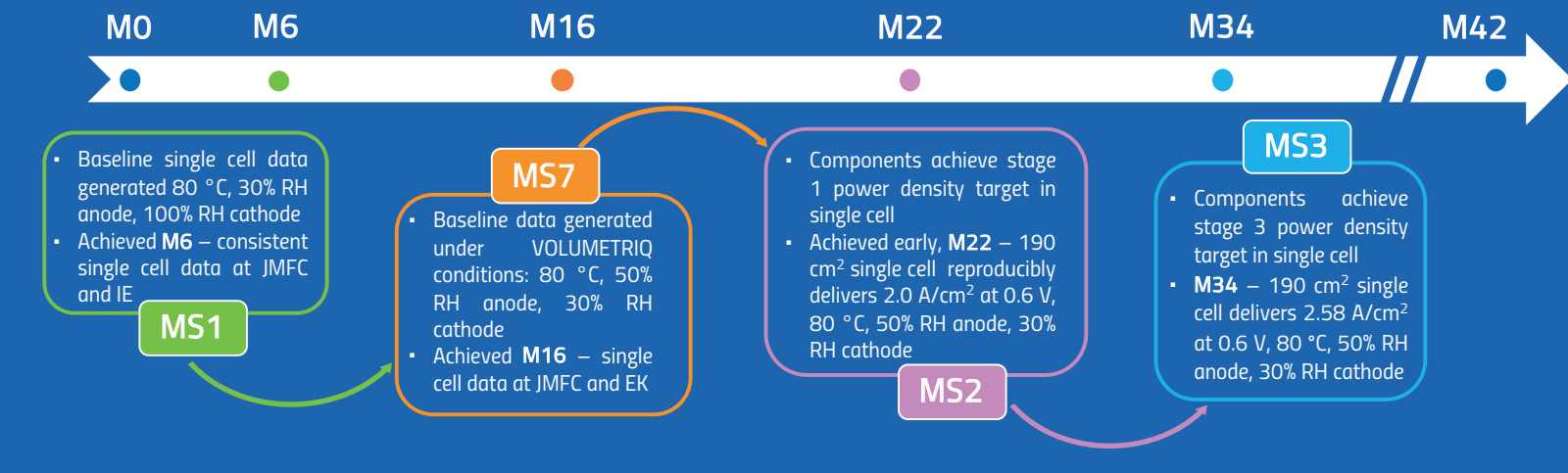
In WP4 JMFC and EK have worked together to meet Deliverable 4.3/Milestone 3 (single-cell performance of 0.6 V @ 2.5 A cm<sup>2</sup> in a relevant test protocol).

The latest design of CCM was realised by using a membrane that was developed in WP3 and a different cathode layer to previous CCMs. Focus on cell build parameters such as compression also helped to achieve impressive results.

A change of GDL improved the power of the cell even further. Milestone 3 was achieved with this GDL change and all of the previous incremental improvements.



## Milestones Status



### Optimisation of the stamping strategies

In the framework of WP5 stamping strategies were developed and the process itself was optimised to expand the current forming limits of BPP and to manage at the same time the process capability. Different approaches were validated to manufacture advanced flow field geometries, namely a multi stage stamping process, the optimisation of the tool coating technology, the improvement of tool manufacturing processes and the implementation of tool setups to produce high precision products.

All approaches have been evaluated via stamping tests with appropriate manufacturing tools.



### Automated Stack Assembly Line - ASAL

A setup for the automated assembly of the stacks (Automated Stack Assembly Line - ASAL) was developed in WP6. ASAL has the capability to assemble up to 20000 stacks annually.

The first stacks were assembled with success.

A parametric sensitivity analysis was performed for every step and component of this procedure and taken into account during the assembly.

Automated Stack Assembly Line - ASAL