Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

- SUPPLEMENTARY INFORMATION -

Bubble Detection on the Cathode and Anode of a High-Performing Capillary-Fed Water Electrolysis Cell

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Independent Replication at University College London (UCL), of the Electrochemical Performance of the Capillary-Fed Electrolysis Cell, as reported in *Nature Communications* 2022, *13*, 1304 (DOI: 10.1038/s41467-022-28953-x) by the University of Wollongong (UOW), Australia.

For acoustic emission testing carried out at University College London (UCL) a different set-up (as detailed in Section 2.2 of the manuscript) was utilised. In order to ensure that the data obtained from these tests was valid and matched data recorded at the University of Wollongong in Australia, previously reported electrochemical performance experiments [1] were repeated, and the data compared. These measurements were independently collected at University College London by co-authors Dr Rhodri Owen and Prof Dan Brett, without the involvement of the original research team from the University of Wollongong. The results are depicted in Figures S1 – S6 below. Dr Owen and Prof Brett were not involved in the original research [1].

Figure S1 (a) shows a polarization curve obtained from the cell operating at 80 ^{o}C following the procedures outlined in reference [1]. Figure S1 (b) shows a comparison of the data obtained in this work (measured at University College London) with the data reported previously in reference [1]. The test was repeated at 85 ^{o}C with the results shown in Figure S2. As observed in both Figure S1 and Figure S2, the cell potential at low current density is lower that reported in Ref [1], a number of factors may have contributed to these observed results, different batches of electrodes, separator and electrolyte were used and while the cell was the same design, it was not the same cell used for the results reported in Ref [1]. In addition to these changes different lengths of gas tubing were used and sent to different sources of extraction. These factors may have influenced the gas pressure slightly and contributed to the slightly different results observed. Regardless of the slightly different performance at lower

current densities, the observed performance is either equal to or slightly higher than that reported in Ref [1] below ~1 A cm^{-2}.

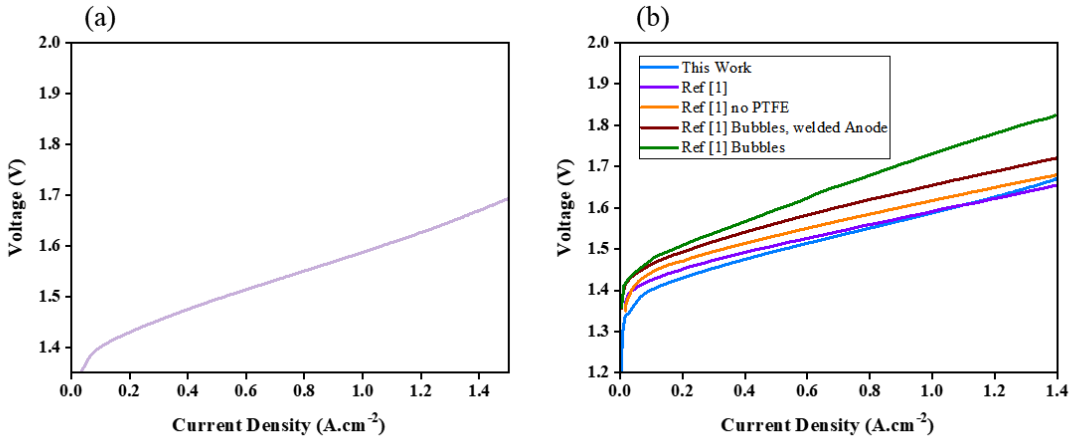


Figure S1. The polarisation curve obtained at 80 °C at University College London as part of this work (a) and compared to the previously reported work conducted at the University of Wollongong [1].

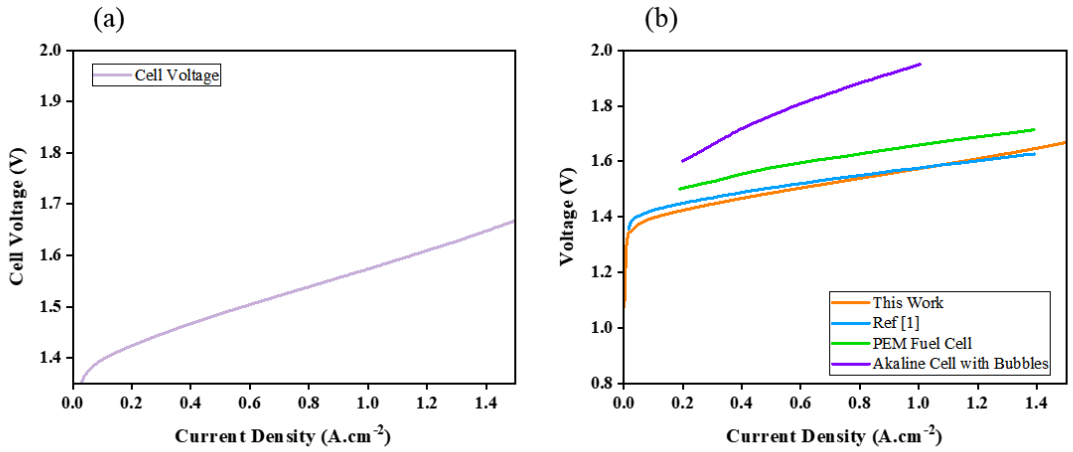


Figure S2. The polarisation curve obtained at 85 °C at University College London as part of this work (a) and compared to the previously reported work conducted at the University of Wollongong [1].

To ensure cell stability was also maintained, the cell was operated at 85 °C and a current density of 0.294 A cm^{-2} for over 40 mins with no reduction in performance observed as shown in Figure S3.

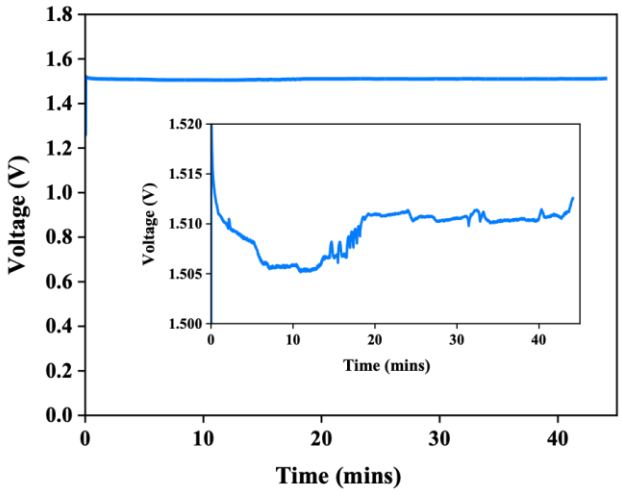
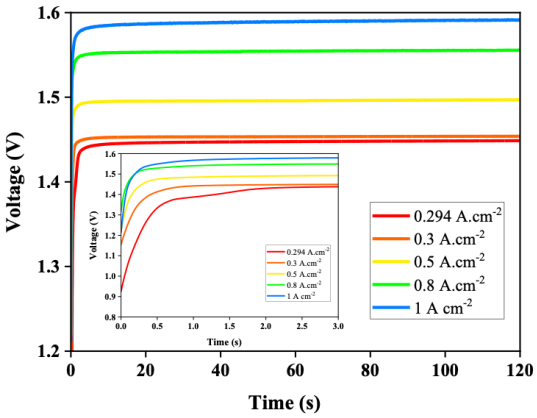


Figure S3. The voltage stability observed for a cell operating at 0.294 A cm^{-2} at 85 ^{o}C. The insert: magnified plot showing the magnitude of the voltage fluctuations observed over this period.

Cell voltage values obtained at several previously reported current densities [1] were replicated and showed good correlation with the previously reported values (Figure S4 (a)-(b)). The rate at which the voltage reaches a steady state is dependent on the current desity under study. The higher the current density the less time is required for the voltage to reach steady state, this is presumable realted to the gas build-up.

(a)



(b)

Current Density ($A.cm^{-2}$)	Cell Voltage (V) Ref [1]	Cell Voltage (V) This Study
0.294	1.470	1.448
0.500	1.506	1.500
0.800	1.551	1.555
1.000	1.575	1.590

Figure S4. Recorded cell voltages at various current densities for a capillary-fed cell operating at 85 ^{o}C. The insert shows the initial voltage profile of each test.

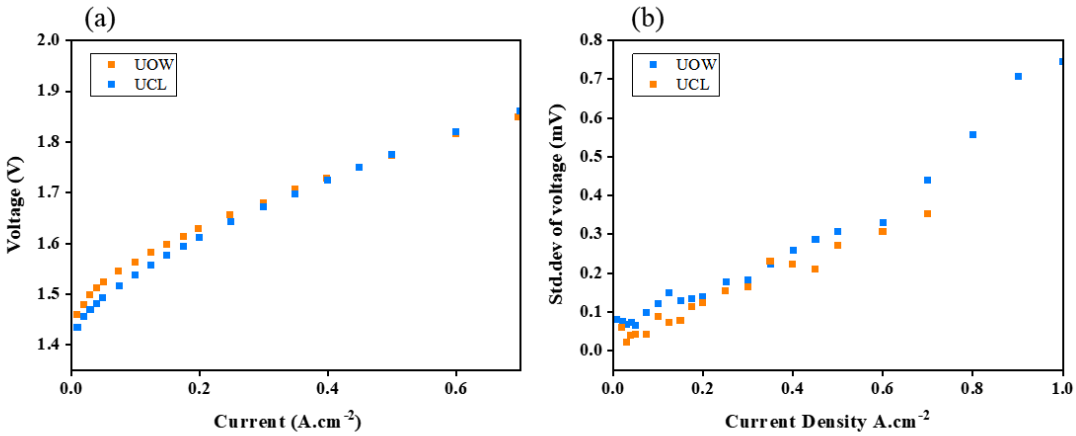


Figure S5. A comparison between the room temperature experimental data collected at University College London (UCL) and the University of Wollongong (UOW): (a) voltage – current plots of the capillary-fed electrolysis cell, and (b) plots of the standard deviation of voltage at fixed current densities of the capillary-fed electrolysis cell (as described in section 2.1.2 – 2.1.3 of the manuscript).

With this study focusing on the perfomance of the cell at room temperature, several of the experiments conducted at University of Wollongong that are included in this mauscript

were repeated at University College London. A good correlation between the tests carried out at each universiy on each set-up was observed as shown in Figure S5.

The volume of hydrogen and oxygen generated at room temperautre with an areal current of 0.350 A cm^{-2} was found to match closely with theoretical values expected if the Faradaic efficiency was 100%, see Figure S6.

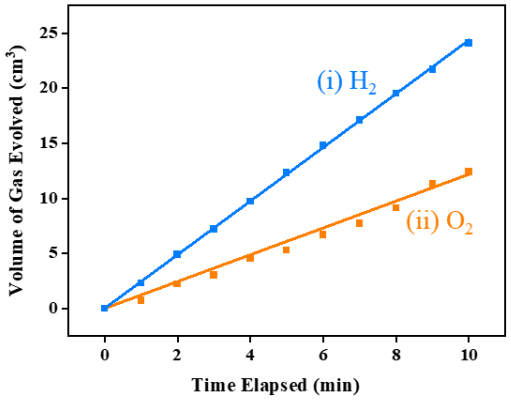


Figure S6. The measured volume of hydrogen and oxygen (dots) produced at room temperature and an areal current of 0.350 A cm^{-2} compared to theoretical values (solid lines) if the Faradaic efficiency was 100%.

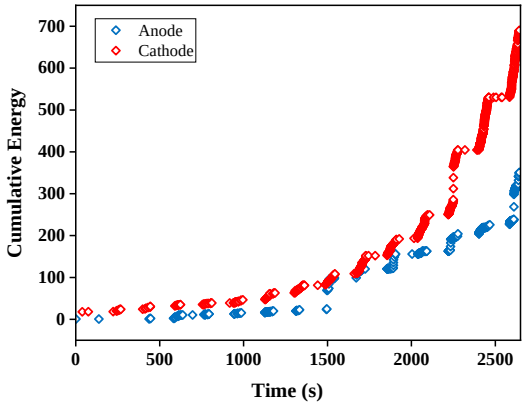


Figure S7. The evolution of the cumulative energy across the course of the test sumarised in Figure 7 of the main manuscript.

References (Supplementary Information only)

[1] A. Hodges, A. L. Hoang, G. Tsekouras, K. Wagner, C.-Y. Lee, G. F. Swiegers, G. G. Wallace. A High-Performance Capillary-Fed Electrolysis Cell Promises more Cost-Competitive Renewable Hydrogen. *Nat. Commun.* **2022**, *13*, 1304.