# Supplementary information

**S1. MES setup diagram**

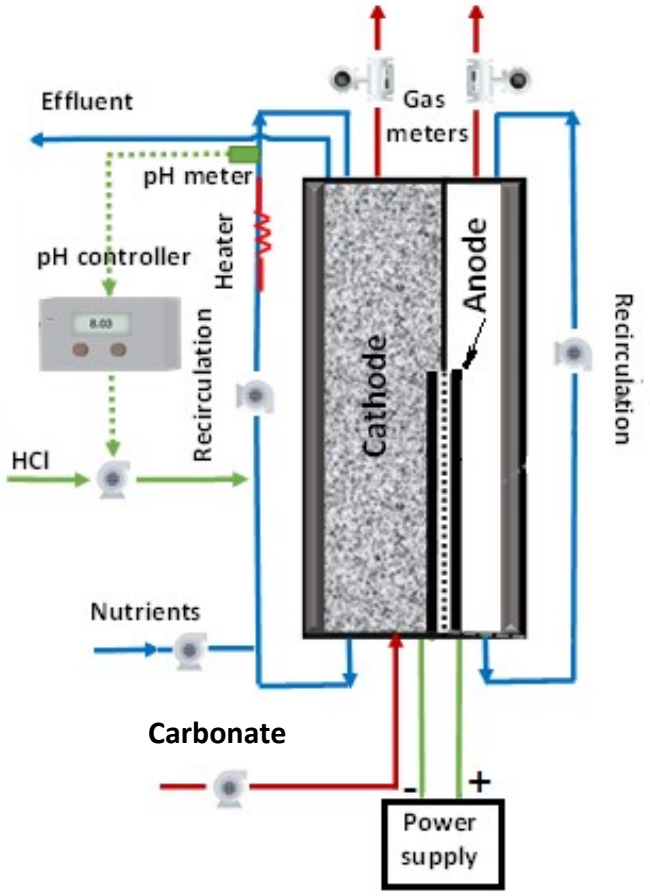


**Figure S1.** Schematic representation of a MES cell with continuous carbonate supply. The dotted line denotes PEM. Figure adapted from Gomez Vidales et al[37].

**S2. Energy consumption and coulombic efficiency calculation**

The energy consumption ($E_{H2}$), per litre of equivalent hydrogen (Wh $L_{H2}^{-1}$), and the Coulombic efficiency (CE) were deteremined as follows:

$$E_{H_2} = \frac{VIt}{\sum_i v_i Q_i} \tag{1}$$

$$CE\ (\%) = \frac{FN\sum_i n_i C_i}{\int_{t=0}^{t} Idt} 100, \tag{2}$$

where $V$ is the voltage (V), $I$ is the current (A), and $t$ is the time (day). $Q_i$ is the flow rate of cathodic products (L $d^{-1}$), $i$ is the cathodic product (i.e., $CH_4$, $H_2$, acetate), and $\nu_i$ represents the stoichiometric amount of $H_2$ necessary to form the given products (mol $mol^{-1}$), which is 4 for both $CH_4$ and acetate. For Equation. (2), $F$ is the Faraday constant (96485 C $mol^{-1}$), while $N$ is the total amount of cathodic products (in mol), $n_i$ defines the equivalent mole of electron required per mole of generated i-th product ($n_i$ is 2 for $H_2$ generation and 8 for $CH_4$ and acetate), and $C_i$ delineats the mole fraction of i in the product (mol $mol^{-1}$).

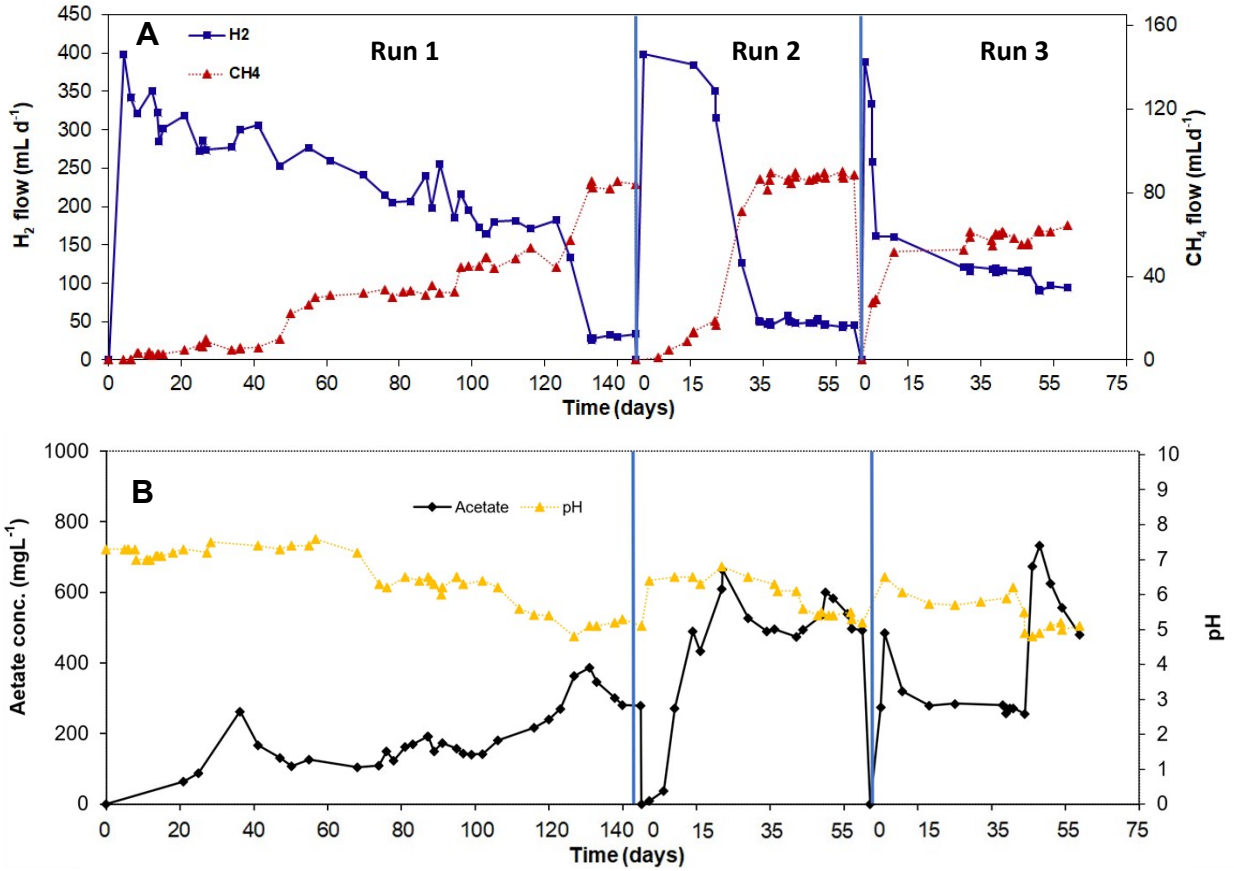


**Figure S2**: Time dependence of (A) $CH_4$ and $H_2$ production rate, (B) Acetate concentration and pH in the cathode compartment of MES-1 cell.

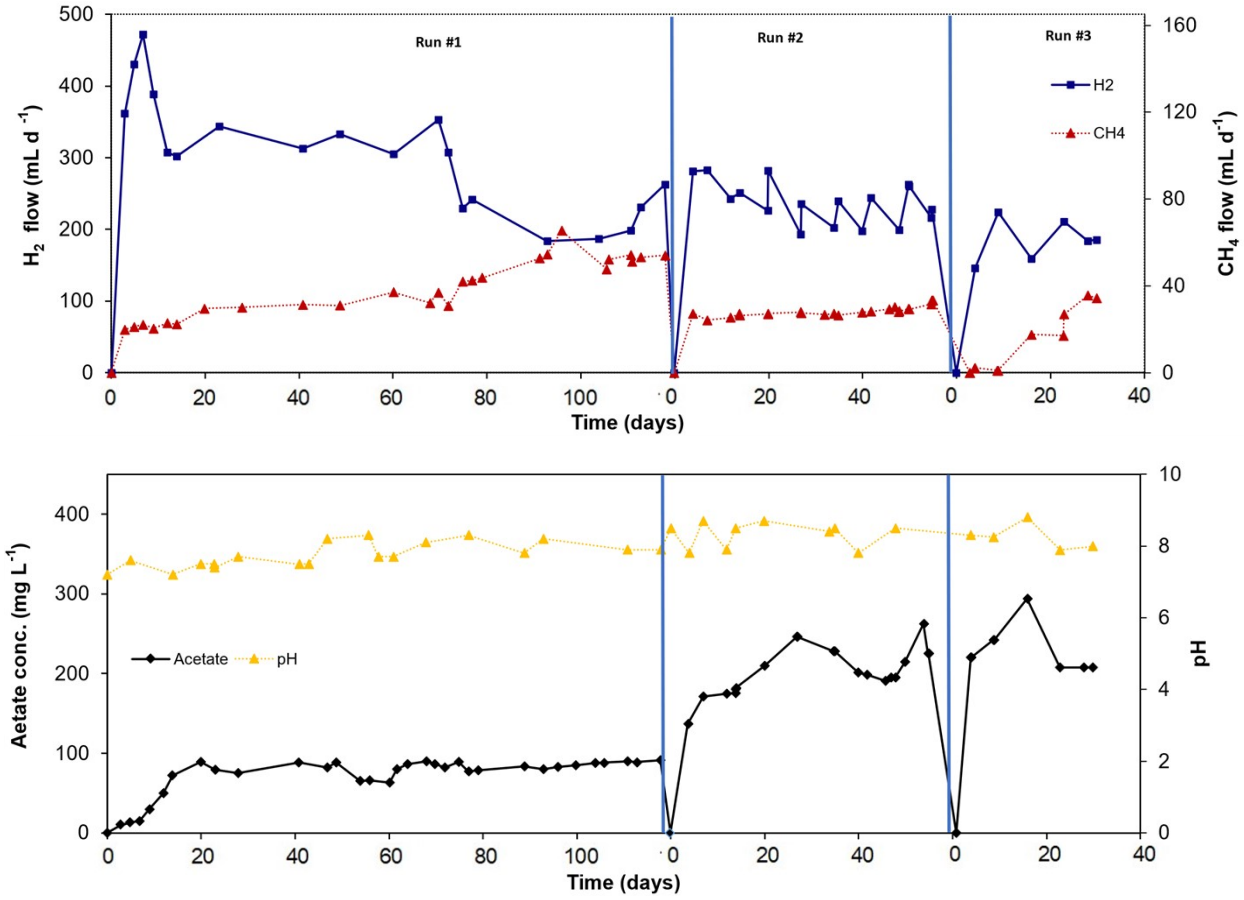


**Figure S3**: Time dependence of (A) $CH_4$ and $H_2$ production rate, (B) Acetate concentration and pH in the cathode compartment of MES-2 cell.