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<th>Strain</th>
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<th>j/A m^{-2}†</th>
<th>Strain</th>
<th>Reference</th>
<th>j/A m^{-2}†</th>
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<td><em>Rhodopseudomonas palustris</em></td>
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<td>&gt;0.001</td>
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</table>

†Current densities from well defined surface area planar electrodes. Therefore, 3D-porous materials were not considered in this compilation; §Combination of suspended fermentative bacteria and electrocatalytic anode materials as reported in 48; §Non pure culture studies showing *Geoalkalibacter* dominated electroactive biofilms derived from environmental samples included here due to the lack of information on pure culture studies on *Geoalkalibacter subterranus*; MFC: Non potentiostatic controlled microbial fuel cells studies included here for sake of completeness although they do not assure similar biological and environmental conditions for both electrodes 49. ARB able to produce significant current densities and thick (>40 μm) biofilms are highlighted in red.
Fig. S1 Exemplary chronoamperometric (CA) measurements of experimental replicates of electroactive biofilms grown on planar graphite electrodes (15 cm²) at an applied potential of +200 V vs. SCE (KCl 3.0 M). *Geoalkalibacter subterraneus* biofilms grown in (A-B) Starkey medium with 35 g/L NaCl and in (C-D) FRR medium with 17 g/L NaCl and for comparison (E-F) shows *Geobacter sulfurreducens* biofilms grown in DSMZ medium No. 826 (see Experimental section for details).
Fig. S2 Comparison of DET formal potentials ($E_f$) for bacteria capable of producing significant current densities and illustrating a sigmoidal shape during turnover conditions in CV measurements. Idea illustration based on50.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>This study</th>
<th>Badalamenti et al.14</th>
</tr>
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<tbody>
<tr>
<td>Current density during CA* in A/m²</td>
<td>4.68 ± 0.54</td>
<td>4.57 ± 0.67</td>
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<td>Applied potential in mV vs. SCE</td>
<td>+200</td>
<td>+200</td>
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<td>Temperature in °C</td>
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<td>Salinity given as NaCl in g/L</td>
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<tr>
<td>pH value</td>
<td>7.0</td>
<td>7.0</td>
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<tr>
<td>BES architecture</td>
<td>Half-cell</td>
<td>Half-cell</td>
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<tr>
<td>Coulombic efficiency in %</td>
<td>114 ± 14</td>
<td>110±1</td>
</tr>
<tr>
<td>Sodium acetate concentration in mM</td>
<td>10</td>
<td>10</td>
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</tbody>
</table>

*CA: chronoamperometry
Fig. S3 A) Turnover cyclic voltammetry (CV) comparison of electroactive biofilms of *Geoalkalibacter subterraneus* (continuous line) and *Geobacter sulfurreducens* (dotted line) grown on graphite plate electrodes (15 cm$^2$) and in B) their respective first derivative. Double head arrows on the top indicate potential windows for formal potentials $E_{f,1}$ and $E_{f,3}$. 
Fig. S4 Comparison of substrate deprived non-turnover cyclic voltammetry of electroactive biofilms. A) *Geoalkalibacter subterraneus* and B) *Geobacter sulfurreducens* immersed in growth medium without electron donor or any other compound capable of being detected in CV. Description: substrate depleted medium was replenished for the respective medium for *Gik. subterraneus* and *Gb. sulfurreducens* strains after substrate consumption during the first CA cycle. These media lacked electron donor/acceptor, trace element solutions, vitamin solution, selenite-tungstate solution, resazurin, yeast extract or any other compound that could give a signal while performing CV. Vertical dashed column indicates common formal potential found for both bacteria possibly indicating a similar DET mechanism.
Fig. S5 Photographs of graphite working electrode before and after a visible reddish biofilm formation by *Geoalkalibacter subterraneus* (red color very likely caused by hemes\(^5\)). A) Bare graphite electrode; B) Graphite electrode completely covered by the biofilm. In this photograph only the side of the graphite working electrode opposite to the Pt/Ir counter electrode is shown and C) The side of the graphite electrode facing the counter electrode showing completely biofilm coverage.

Table S3: PHLIP Analysis of mature electroactive biofilms.

<table>
<thead>
<tr>
<th>Strain</th>
<th>Electrode coverage/ %</th>
<th>Thickness/ µm</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Geoalkalibacter subterraneus</em></td>
<td>23 ± 7</td>
<td>76 ± 7</td>
</tr>
<tr>
<td><em>Geobacter sulfurreducens</em>†</td>
<td>31 ± 16</td>
<td>46 ± 22</td>
</tr>
<tr>
<td>Graphite‡</td>
<td>5 ± 2</td>
<td>20 ± 1</td>
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</table>

†Positive biofilm control and ‡Negative biofilm control
**Fig. S6** Stack of metabolically active 1-µm slices of a *Glk. subterraneus* biofilm. Bar: 120 µm.
Fig. S7 Exemplary Volocity® 3D reconstructions of CLSM slices of electroactive biofilms. A-B) Geoalkalibacter subterraneus, C-D) Geobacter sulfurreducens and E-F) Graphite electrode not potentiostatically controlled from Table S3 (1 unit = 1 little square edge = 37.51 μm, the observed surface was thus 375 μm × 375 μm).
**Figure S8:** Exemplary confocal laser scanning microscopy of (A-B) *Geoalkalibacter subterraneus* and (C-D) *Geobacter sulfurreducens* biofilms grown on graphite plate electrodes potentiostatically controlled. E-F) Negative control electrode not potentiostatically controlled illustrating a lack of biofilm growth on the electrode surface. Maximum intensity projections: A, C and E. Orthogonal cross sections of single slices through the biofilm with top and right panels representing perpendicular slices: B, D and F.
**Fig. S9** A) FRR$^{52}$ medium in serum bottle modified from the Hungate technique$^{53}$ for the growth of *Geoalkalibacter subterraneus*; B) FRR medium inoculated with 20% v/v of *Geoalkalibacter subterraneus* cells incubated anaerobically at 37°C after gently shaking (Orbital shaker, Model 3540, Bioblock, Fisher Scientific SAS, F67403 Illkirch, Cedex, France) for 48 h; and C) Harvested *Geoalkalibacter subterraneus* cells by centrifugation at 3000 rpm during 10 min.
References: