

**CONCEPT PAPER**  
**for KIER International Cooperation project**

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<b><u>Title</u></b>	Upgrading Biogas via Electric-Field Assisted Catalytic Reactor			
<b><u>Description</u></b>	<p><b><u>Project summary:</u></b> Our proposed technology will utilize an electric-field effect to enhance the catalytic reactor performance for upgrading CO<sub>2</sub> containing biogas into synthesis gas by developing the electric-field assisted methane steam reformer. This synthesis gas will be fed to Fischer Tropsch synthesis reactor for producing logistic transportation liquid fuels (<i>See Figure 1</i>).</p> <p><b><u>Barrier(s) to tackle:</u></b> Biogas derived from bio-wastes has been recognized as a valuable renewable energy sources to decrease our dependency on crude oils. Since biogas is mostly consisted of CH<sub>4</sub> and CO<sub>2</sub> gases, it is most useful if it can be upgraded into the logistic transportation liquid fuels. Currently, CO<sub>2</sub>-containing biogas is upgraded into synthesis gas via a steam reforming process after removing CO<sub>2</sub> from the biogas followed by adding H<sub>2</sub>O into the biogas. However, CH<sub>4</sub> is very stable and activating its C-H bonds is very challenge process. Thus, it requires a high operating temperature and an excess amount of H<sub>2</sub>O at the elevated temperatures to prevent the surface coking. Consequently, its capital cost and its overall operating cost are high.</p> <p><b><u>Strategy to solve:</u></b> We will enhance CH<sub>4</sub> activation step using the electric-field generated by the renewable energies. This electric-field assisted fuel reforming is very noble technology because one can manipulate both thermodynamic and kinetic reaction parameters by simply applying the electric field with a different field direction and magnitude. It has been hypothesized and proven by DFT calculation that the partially and positively charged Ni surface shows a higher activity toward first C-H bond session of CH<sub>4</sub> molecule. For our proposed technology, the electric-field will be applied over the specially designed Ni catalyst bed to precisely control its surface charge state and its overall surface electric properties. By controlling its field direction and magnitude, we can manipulate its reaction energy, equilibrium constant, reaction rate and reaction selectivity.</p>			

<p><b>Description</b></p>	
<p><b>Outcomes</b></p>	<p><b>Figure 1.</b> Schematic of Proposed Electric-Field assisted Catalytic Reactor for Efficient Biogas Conversion.</p> <ul style="list-style-type: none"> <li>• <b>Expected Benefits:</b> <ul style="list-style-type: none"> <li>➢ Operating cost down for H<sub>2</sub> production from small module units (11,000 \$/kg/day to 7,000 \$/kg/day),</li> <li>➢ An annual CO<sub>2</sub> emission reduction of 10<sup>6</sup> tons (10<sup>6</sup> tCO<sub>2</sub>/year) in South Korea alone is expected (assuming that 50 plants with 10 bpd synthetic fuel capacity are built in South Korea). Globally, an annual CO<sub>2</sub> emission reduction of 10<sup>8</sup> tons (10<sup>8</sup> tCO<sub>2</sub>/year) is expected (assuming that 500 plants with 100 bpd synthetic fuel capacity are built).</li> </ul> </li> <li>• <b>Publications and/or Patents:</b> <ul style="list-style-type: none"> <li>➢ 1 SCI publication and 1 patent</li> </ul> </li> </ul>