As the search for unique and more efficient power surges forward, discovery and innovation abound. Batteries are becoming lighter, smaller, and quicker to charge. One specific innovation is the lithium-oxygen battery: this battery is distinguishable in its ability to be recharged many times without decomposing. While this battery is still being tweaked to optimize energy efficiency, it has potential in the automotive industry to create more efficient electric vehicles. One of the most enticing features of the lithium-oxygen battery for engineers and researchers is its power output relative to its mass (gravimetric energy density), which is higher than any other battery’s. Lithium’s low mass, in conjunction with oxygen gas, contribute heavily to the gravimetric energy density of 1700 Wh/kg. This means, firstly, that a lithium-oxygen battery can produce a much greater output than conventional batteries of the same weight. Alternatively, lighter batteries can be created which would result in lighter electric vehicles, a current goal for automakers. Both options will allow the automotive industry to become more efficient in terms of energy expenditures, making electric vehicles more sustainable and economically competitive.

### Pros

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>High gravimetric energy density</td>
<td>Produces 300 grams per kilogram equivalent CO₂ in greenhouse gas</td>
</tr>
<tr>
<td>Lightweight battery</td>
<td>Moisture in air decreases power output</td>
</tr>
<tr>
<td>Would decrease weight of electric vehicles</td>
<td>Side reactions’ byproducts mar interfacial chemistry</td>
</tr>
<tr>
<td>Reaches a 90% energy efficiency</td>
<td>More research is needed to settle on a suitable electrocatalyst</td>
</tr>
<tr>
<td>Could increase marketability of vehicles</td>
<td>Innovations in cycling performance are necessary</td>
</tr>
<tr>
<td>Could compete with the internal combustion engine</td>
<td></td>
</tr>
</tbody>
</table>

### Benefits:

- The lithium-oxygen battery is more energy efficient than an internal combustion engine, with minimal energy lost as heat.
- The electrochemical cell’s low mass and high gravimetric energy density allow it to compete with the internal combustion engine, making it more economically viable.

### Limitations:

- The battery outputs 300 grams per kilogram of CO₂ equivalent.
- Current procedures for recycling the lithium-oxygen battery properly are unresolved.

### Reactions

**Charging Reactions**

\[
\text{Li}^+ + \text{O}_2 + e^- \rightarrow \text{LiO}_2, \\
\text{LiO}_2 + \text{Li}^+ + e^- \rightarrow \text{Li}_2\text{O}_2
\]

or, alternatively

\[
2\text{LiO}_2 \rightarrow \text{Li}_2\text{O}_2 + \text{O}_2 \quad [2]
\]

**Discharging Reaction**

\[
\text{Li}_2\text{O}_2 \rightarrow 2\text{Li}^+ + \text{O}_2 + 2e^- \quad [2]
\]

The picture to the right depicts a current electric cars’ (the Nissan Leaf’s) mileage range while using lithium-ion batteries, as compared to other rechargeable batteries. While still undergoing research and development, the lithium-oxygen battery is projected to significantly expand an electric vehicle’s range.

### References:


