**MiTRE**

A Micro Turbine Range Extender for Electric Vehicles

### Electric Vehicles Drawbacks

- Limited real-world range
- Acquisition price higher than ICE vehicles
- Heavy and expensive batteries
- Poor overall lifecycle performance of large battery packs and BEVs

### Philosophy

- 130km electric range covers 98% UK daily driving requirements
- 30kWh battery system can cover this range
- Roughly 1/3rd of Audi e-tron or Jaguar I-Pace battery size
- Range extender used to cover occasional longer trips

### Impact of having 130km electric range and MiTRE range extender on sample vehicles

<table>
<thead>
<tr>
<th>Model</th>
<th>Battery Capacity kWh</th>
<th>WLTP Range km</th>
<th>Electric Range km</th>
<th>Vehicle Mass Reduction kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMW i3 (2019)</td>
<td>42.2</td>
<td>421</td>
<td>311</td>
<td>20.3</td>
</tr>
<tr>
<td>Audi e-tron</td>
<td>44.0</td>
<td>401</td>
<td>289</td>
<td>20.5</td>
</tr>
<tr>
<td>Hyundai Kona</td>
<td>40.0</td>
<td>401</td>
<td>289</td>
<td>20.5</td>
</tr>
<tr>
<td>Kia e-Niro</td>
<td>67.0</td>
<td>455</td>
<td>401</td>
<td>25.5</td>
</tr>
<tr>
<td>Nissan Leaf</td>
<td>40.0</td>
<td>270</td>
<td>20.4</td>
<td>38</td>
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<tr>
<td>Mercedes EQA</td>
<td>60.0</td>
<td>345</td>
<td>305</td>
<td>20.3</td>
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<tr>
<td>DS 3 Crossback E-Tenax</td>
<td>35.0</td>
<td>346</td>
<td>305</td>
<td>236</td>
</tr>
<tr>
<td>Jaguar I-Pace</td>
<td>37.0</td>
<td>346</td>
<td>305</td>
<td>236</td>
</tr>
<tr>
<td>Audi e-tron Sportback</td>
<td>35.0</td>
<td>346</td>
<td>305</td>
<td>236</td>
</tr>
</tbody>
</table>

### System Benefits Compared to Equivalent Piston Range Extenders

- Runs very cleanly:
  - Very low CO and NOx emissions
  - Emissions after-treatment system not required even for most stringent applications
- Lower system mass and size → Low cost at high volume
- Fuel quality tolerant
- Can be used with different fuels without extensive modifications
- Reliable
- Low maintenance
- Easy integration in different applications
- Works in any position and orientation
- Reduced NVH

### Vision

- No range anxiety
- No need for a conventional second vehicle
- No requirements for large batteries
- Reduced end of life impact
- Reduced weight and price

### Concept: Turbomachinery Coupled with an Electric Machine

- High speed = Low torque = Small generator → Low cost
- Optimized temperatures and pressures to use mainstream materials
- Recuperated cycle to increase turbine efficiency
- Single set point operation to optimize emissions and efficiency
- Low emissions
- Simple vehicle integration
- One moving component → Simplicity and cost saving

### MiTRE is in pre-production testing and will be available for prototype integration from autumn 2019

### References