Hybrid-electric propulsion for sustainable aviation & new mobility concepts

Julia Hetz I Head of Marketing eAircraft
Aviation as of today is not sustainable – the future and the industry call for environmentally friendly and economical flight solutions

**Emissions**
Targets can only be reached with disruptive concepts

**Operating cost**
Fuel consumption is main lever to reduce aircraft TCO

**Noise**
Extension of operating ranges through noise reduction

- extension of potential operating hours
- use of smaller airfields
- in-city operations

---

With air transport continuously rising, new solutions are needed to increase efficiency and to limit damaging effects on the environment: aircraft technology that limits noise and emissions without jeopardizing safety.

1) IATA technology roadmap, June 2013
2) example 737-800
### Hybrid-electric propulsion systems are key technology for sustainable flight

#### Useful range
- Distributed propulsion
- Vectorized thrust

#### Decreased fuel consumption
- Separation of power generation and thrust generation

#### Silent propulsion
- Hybrid-electric propulsion

#### Increased aerodynamic efficiency
- Separation of power generation and thrust generation

#### eSTOL, eVTOL
- Electric drive systems enable the use of non-fossil fuels or completely new technologies to generate power for flight. And they open up new design spaces: energy and thrust generating components can be physically separated to reduce drag and noise.

---

1) STOL: Short Take-Off and landing
VTOL: Vertical Take-Off and Landing
Siemens eAircraft offers electric propulsion units for applications with high power/torque to weight requirements

eAircraft develops electric and hybrid-electric propulsion system for flight in power classes ranging from below 100 kW to several MW.

The core portfolio covers everything between the propeller and the pilot, but does not include turbines, fuel cells or gears.
After small propeller aircrafts we see a possible market entry for air taxis and commuter aircrafts by the middle of the next decade

<table>
<thead>
<tr>
<th>System power and complexity</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short range aircraft</td>
<td>150-250</td>
<td>&lt; 50 MW</td>
<td>Radical leap for propulsion technology and new A/C concepts needed</td>
</tr>
<tr>
<td>Regional aircraft</td>
<td>&lt; 150</td>
<td>&lt; 20 MW</td>
<td>Development and testing of disruptive technologies for hybrid-electric flight by 2030</td>
</tr>
<tr>
<td>Commuter &amp; business aircraft</td>
<td>&lt; 19</td>
<td>&lt; 2 MW</td>
<td>First market introduction possibly mid-2020's with electric and hybrid-electric propulsion</td>
</tr>
<tr>
<td>Urban Air Mobility (VTOLs)</td>
<td>1-4</td>
<td>&lt; 1 MW</td>
<td>First commercial route in Norway</td>
</tr>
<tr>
<td>Small propeller aircraft</td>
<td>1-4</td>
<td>50-300 kW</td>
<td>Market introduction highly dependent on infrastructure and regulatory development</td>
</tr>
</tbody>
</table>

Hybrid-electric propulsion is a scalable technology, making its way into:
- General aviation by 2018-2022
- Commercial aviation (<100 passengers) by 2030
- eVTOL potentially in a large number (economy of scale)

1) VTOL: Vertical Take-Off and Landing

Initial technology | Flight testing | Market penetration

Unrestricted © Siemens 2019.
Page 6     June 27, 2019
The eAircraft portfolio has been designed to meet aerospace requirements and is now on the way to industrialization & certification.

The eAircraft portfolio has been shaped by close collaboration with partners such as Airbus.

In the lower power classes, the systems have already been tested in flight and are being installed in first commercial applications.

In the high power classes, a 2 MW lab demonstrator is currently awaiting test results and a design of a 10 MW generator based on superconducting technology exists as digital twin.
A successful start-up story: acquisition by Rolls-Royce accelerates achievement of sustainable flight vision (announced June 18, 2019)

### Market and competition

<table>
<thead>
<tr>
<th>Fast market development requiring industrialization speed</th>
<th>Strong competition</th>
<th>High capital invest in new enterprises</th>
</tr>
</thead>
</table>

### Competencies

**SIEMENS eAircraft**

- Innovative developments
- Strong team and competencies
- Successful technology demonstration
- Customer access in general aviation market
- Pioneer and driver of electric aviation vision

### Technology & business prospects

- Leading supplier of propulsion systems
- Strives to become the leading supplier of electric and hybrid-electric propulsion systems for aircraft
- Experience in industrialization, certification and marketing of products for the aerospace industry
- Certified design organization
- Established customer relationships in commercial aviation markets

**Sustainable, lower-emission, silent aviation with hybrid-electric propulsion systems**
Contact

Julia Hetz
Head of Marketing eAircraft
Corporate Technology / Germany / CT CTP AIR S&BD
Otto-Hahn Ring 6
81739 München
Mobile: +49 173 72 73 72 6
E-Mail: julia.hetz@siemens.com

siemens.at/future-of-energy