Ultra light ELAPHE* in-wheel motors
Our purpose is...

...to combine performance, economy and ecology in an in-wheel propulsion, that will take over the city car market.
City car market

Currently populated by ICE cars:
- Smart
- Toyota IQ
- Volkswagen Lupo
- ...

Companies announced electric models:
- Renault-Nissan
- Mitsubishi
- Smart
- ...
- Numerous specialized electric car companies
Automotive electrification

The percentage of the electric city car market occupied by a car model depends on how it addresses key market drivers.

Source: “International futures”; .....
Key market drivers

- Vehicle purchase price
- Maintenance costs
- Fuel/energy cost
- Functionality
- Comfort
- Design

Most of these drivers can be better addressed with an in-wheel electric drive than with current solutions.
Current solution problems
- Internal Combustion Engine

Vehicle purchase price:
- Heavy power transmission parts (transmission, gearbox, differential)
- High number of auxiliary systems
- Expensive engine subframe

Maintenance costs:
- Hundreds of moving parts
- Limited lifetime parts (oil and air filters, belts, sparkplugs,…)

Fuel cost:
- Very low propulsion efficiency
- Heavy vehicle
- High and unpredictable oil prices
- Engine not optimized for the typical driving cycle

Other problems:
- Limited design options
- Environmental issues
Current solution problems
- Central electric motor

Vehicle purchase price:
- Heavy power transmission parts (transmission, gearbox, differential)
- Bigger and heavier electric motor

Maintenance costs:
- Still a number of moving parts

Fuel cost:
- Heavy vehicle
- Engine not optimized for the typical driving cycle
- Average overall drive efficiency 60-65%

Other problems:
- Limited design options
ELAPHE* in-wheel solution

Vehicle purchase price:
- Engine fitted directly into the wheel - no transmission parts
- Lower potential production price than competitive electric motors
- Up to 20% less energy storage needed (compared to central electric drive)
- Short development cycles

Maintenance costs:
- Only one moving part

Fuel cost:
- High propulsion efficiency
- Lighter vehicle
- Motor optimized for the typical driving cycle (average efficiency over 80%)

Other benefits:
- Design and functionality freedom
- Low environmental impact
## Breakdown of ELAPHE* technology benefits

<table>
<thead>
<tr>
<th>Drivers addressed</th>
<th>ELAPHE* electromagnetic topology</th>
<th>Unique customization tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOWER vehicle PURCHASE PRICE</td>
<td>ULTRA LOW MOTOR WEIGHT</td>
<td>HIGH OVERALL EFFICIENCY</td>
</tr>
<tr>
<td></td>
<td>Lower motor production price</td>
<td>Less energy storage</td>
</tr>
<tr>
<td>REDUCED FUEL COST</td>
<td></td>
<td>Less energy consumption</td>
</tr>
<tr>
<td>FUNCTIONALITY and COMFORT</td>
<td>Low unsprung weight</td>
<td></td>
</tr>
</tbody>
</table>

[www.in-wheel.com](http://www.in-wheel.com)
Competitive advantages -
Direct competition

**ELAPHE* patented electromagnetic topology**

- 15 % lighter motor for the same performance
- 15 % lower production price

**Unique fast customization tool:**

- Motor design takes days instead of weeks
- Increase in average energy efficiency
- Further weight and production price reduction (no over-dimensioning)

**Elaphe Team:**

- Mixture of experience and ambition
ELAPHE team

Founders:
Gorazd Lampič, CEO
• 7 years of experience in direct drive development
• Leading national expert in EVs and advanced energy sources

Andrej Detela
• Inventor of the KDU robotic direct drive for HDS
• 20 years of experience in direct drive development
• 40 years of research experience

Core research and PM:
Gorazd Gotovac, Matic Franko, Joško Valentinčič

Close cooperation with research institutions:
Jozef Stefan Institute – the largest research institute in the region
Main University in the region
Track record

Elaphe*1 - proof of theory
Elaphe*2 - Simplification of construction, cogging torque red.
Elaphe*ET - 30 kW cont. power, cooling
Elaphe*3 - Driveable scooter
Elaphe*kolo - Bike
Elaphe*Chebela - city electric car motor
Elaphe*IM
Elaphe*A1

2003  2005  2007  2008  2009  2010
ELAPHE* Chebela

Small electric car project

• Local industry initiative

• 2 × ELAPHE* Chebela in-wheel motors

• First motor prototypes already produced

• Start of production 2012

www.in-wheel.com
ELAPHE* product

Customized off the shelf in-wheel electric drive

- ELAPHE*
electromagnetic topology

- Customized with the Unique fast customization tool

www.in-wheel.com