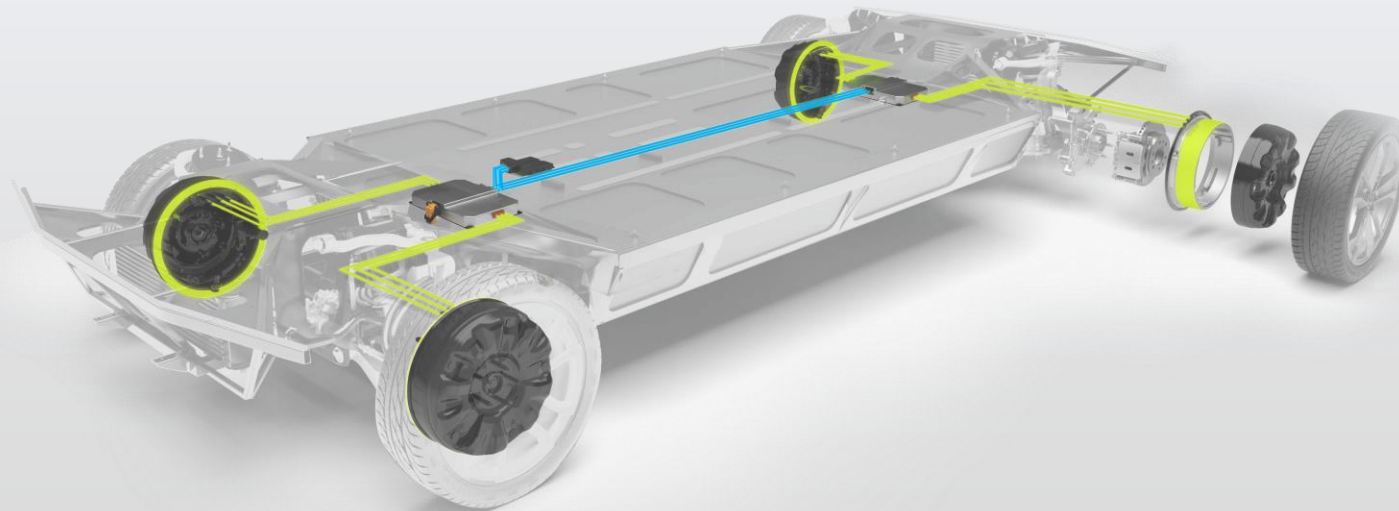


## New powertrain architecture for radically reduced electric vehicle energy demand



Aljaž Dvoršak  
*account manager*

# Elaphe in a nutshell

Research work 1980s  
Established 2006



Full system including  
multiple wheel control



Validated on benches  
and in 100+ vehicles



First customer launches:  
2 models – Q4 2022  
1 model – Q2 2023



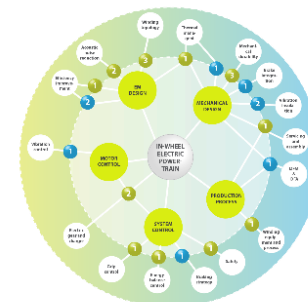
150 dedicated employees



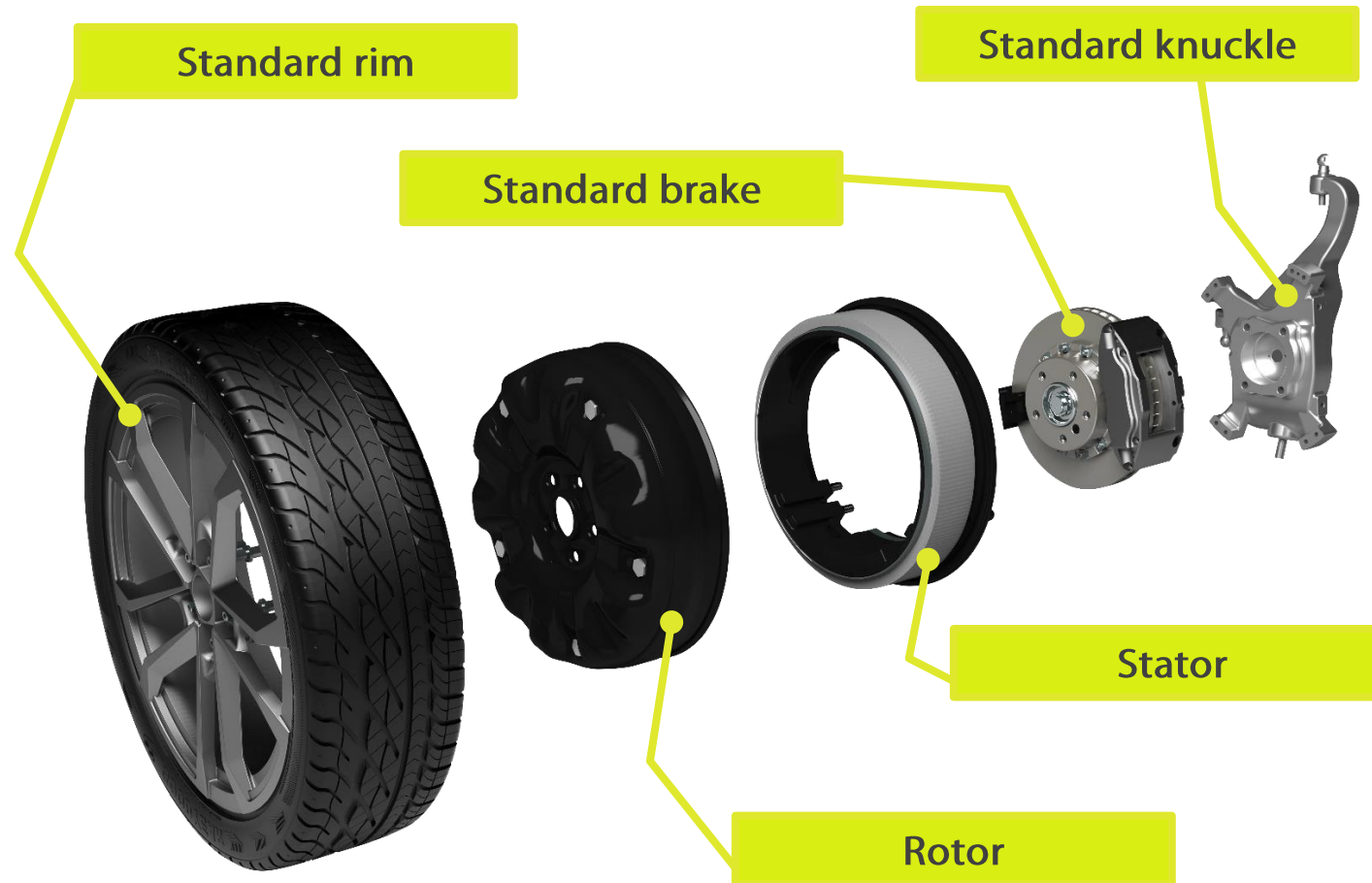
Global presence



Innovative patented solutions



# In-wheel motor



# EV market segmentation



# EV market differentiation – vehicle mission



Track capable sportscar



High straight line acceleration



Substantial daily range without charging



Long range cruising



Second family vehicle  
for city use



Personal mobility



Versatile family vehicle



Eco-friendly truck

# Emerging ultra-efficient vehicle class



## Vehicle features

- Low air drag coefficient  $<0.2$
- Lightweight structures
- Low rolling resistance tires
- Holistic optimization of internal losses on all vehicle systems

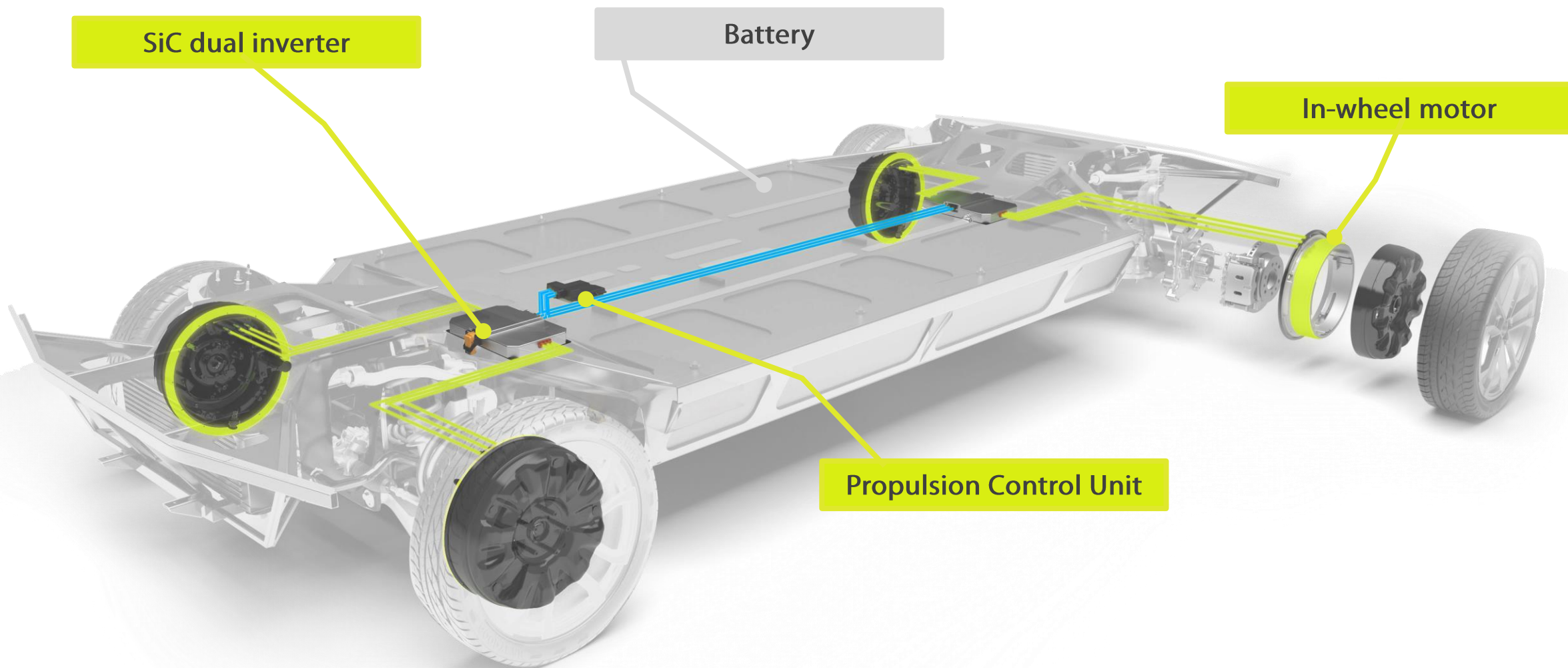
## Vehicle benefits

- 1000 km per charge feasible without major cost
- 50% lower energy consumption than state-of-the-art
- Useful autonomy without charging possible (solar)
- Very fast range replenishing
- Lower dependence on external conditions



Our products

# In-wheel motor propulsion system



# Vehicle architecture benefits



## Powertrain benefits

- Minimal footprint
- No gearbox, no half-shafts
- Direct drive – no mechanical losses
- Standard brake, bearing knuckle and rim compatibility

## Vehicle benefits

- Weight reduction
- Extended range
- Improved vehicle dynamics and manoeuvring & safety
- Released space for a larger battery
- Aerodynamic design

## End user benefits

- Increased space in same vehicle volume
- Increased trunk/frunk
- Software defined vehicle & autonomous ready
- User-centred design & functionalities

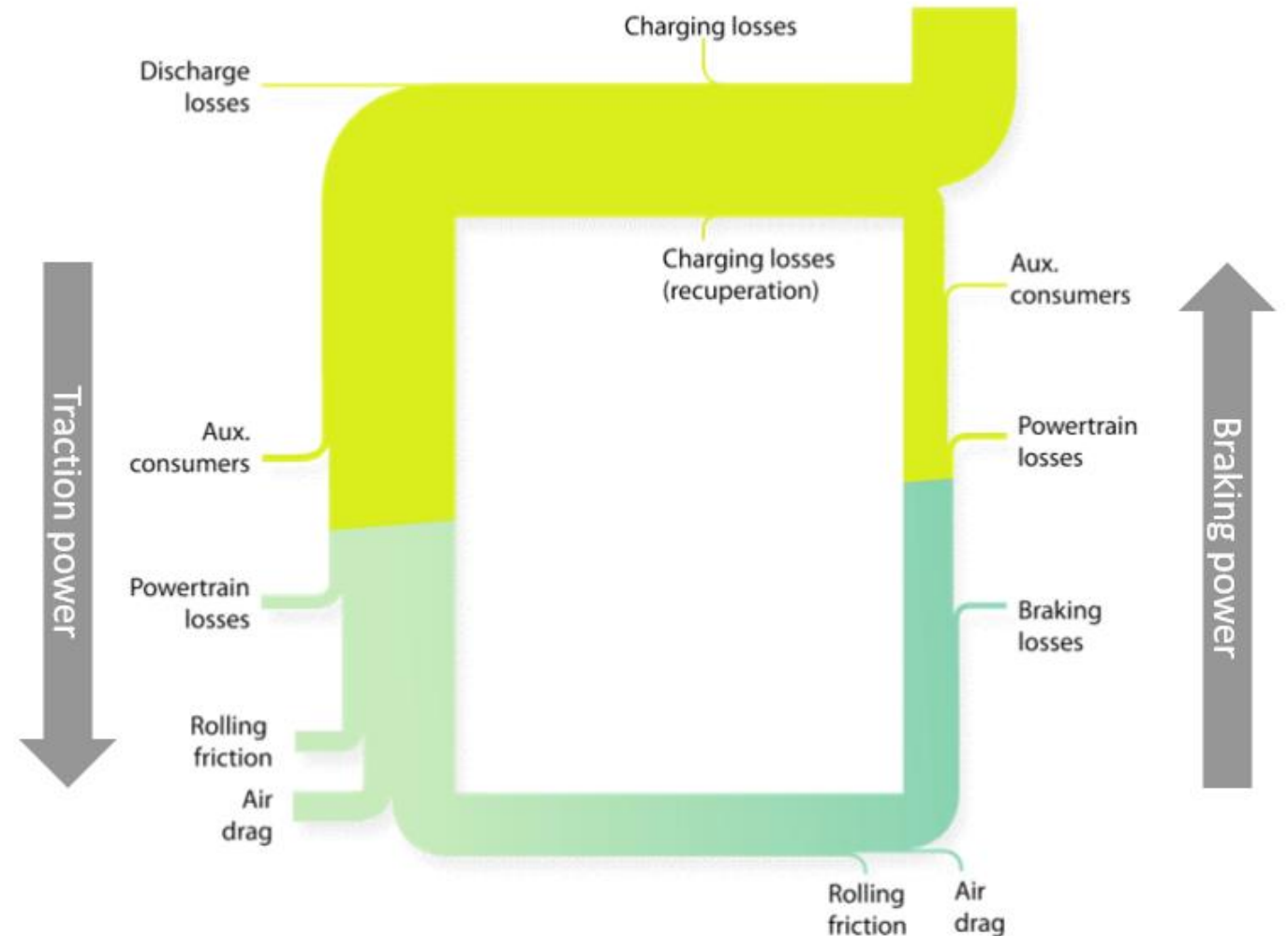
## OEM benefits

- Accelerated time to market
- Less parts & less complexity
- Economies of scale through modularity across platforms and design versatility
- Standard parts-compatible



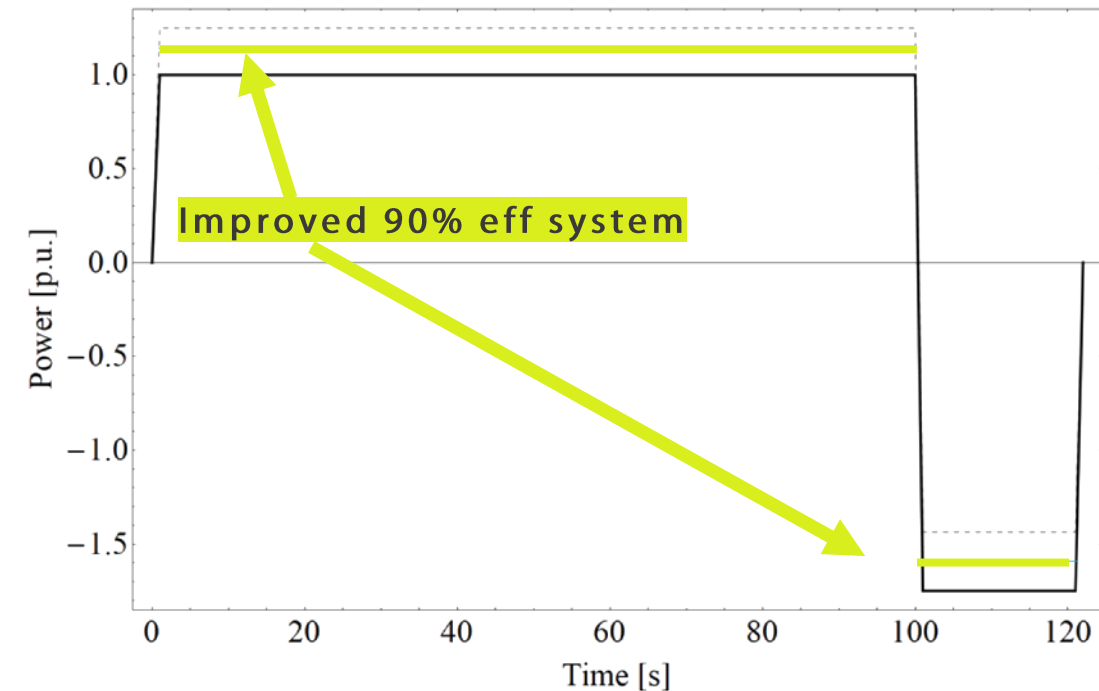
# Propulsion efficiency on vehicle level

- Focus on air-drag:
  - Reduction of  $C_d$
  - Reduction of frontal area
- Focus on rolling resistance
  - Improved tires
  - Rim size, shape and form factor
  - Reduced vehicle mass
- Maximizing regeneration availability
- Improved thermal management
  - Less sensitivity to temperature
  - More efficient cooling of components
- Improvement of losses of each internal component



# Role of PT in energy consumption

Generic case representative, generic vehicle with 55 Wh/km vehicle losses in WLTP cycle and a 50 kWh battery.



Vehicle center efficiency:  $\eta_{cyc} = \frac{Wheel^+ - Wheel^-}{DC^{IN} - DC^{OUT}}$

If PT 80% efficient  $\eta_{cyc} = \frac{\int P_{loss,veh} dt}{\int P_{loss,veh} dt + \int P_{loss,PT} dt} \cong 65\%$  590 km range

If PT 90% efficient  $\eta_{cyc} = \frac{\int P_{loss,veh} dt}{\int P_{loss,veh} dt + \int P_{loss,PT} dt} \cong 80\%$  715 km range (+21%)

This simple case clearly shows that the difference in the outcome can be higher than proportional to the efficiency improvement.

# PT losses comparison

## IWM

### Contributions to losses:

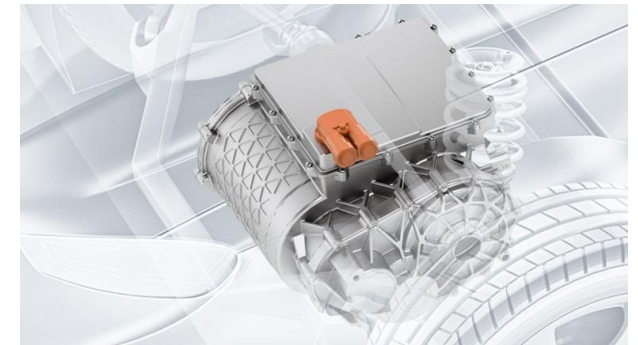
- Joule losses in the e-motor
- Frequency losses in the e-motor
- **Seal losses**
- Inverter losses
- Cable losses
- Vehicle bearing losses \*



## E-axle

### Contributions to losses:

- Joule losses in the e-motor
- Frequency losses in the e-motor
- Inverter losses
- Cable losses
- **Gear losses incl. bearings and seals \***
- **Driveshaft losses, differential losses \***
- **Joint losses \***
- Vehicle bearing losses \*



# Serial production vehicles



## Lordstown Endurance



**World's first SUV with an in-wheel powertrain**

### **Mission**

A reliable fleet vehicle for businesses with a focus on reducing maintenance costs

### **Highlights**

- 4x in-wheel motor, combined peak power of 550 HP and 6700 Nm of torque
- 200 miles range with 109 kwh battery
- large frunk (front trunk)

# Serial production vehicles



**World's first ultra-efficient solar 3-wheeler**

## **Mission**

Highly efficient solar ultra light EV

## **Highlights**

- Solar cells embedded into composite body
- up to 41 miles of solar range on a typical sunny day in California
- Impeccable aerodynamics, air drag coefficient of 0,13
- 3x in wheel motor, combined power 150 kw
- Daily commuter or sport utility vehicle

# Serial production vehicles



**Worlds most efficient full-size sedan EV**

## **Mission**

Full-size 5-seater solar vehicle with over 1000 km range

## **Key features**

- Aerodynamic design, airdrag  $C_d < 0,19$
- 625 km WLTP battery range with 60 kWh battery
- 70 km of solar range on a sunny day
- Over 1000 km of practical range due to solar charging with 50km daily commute drives
- 4x custom in-wheel motor with achieved 97% efficiency
- 91% WLTP powertrain efficiency





\*

Put the **power** where it's needed.

