



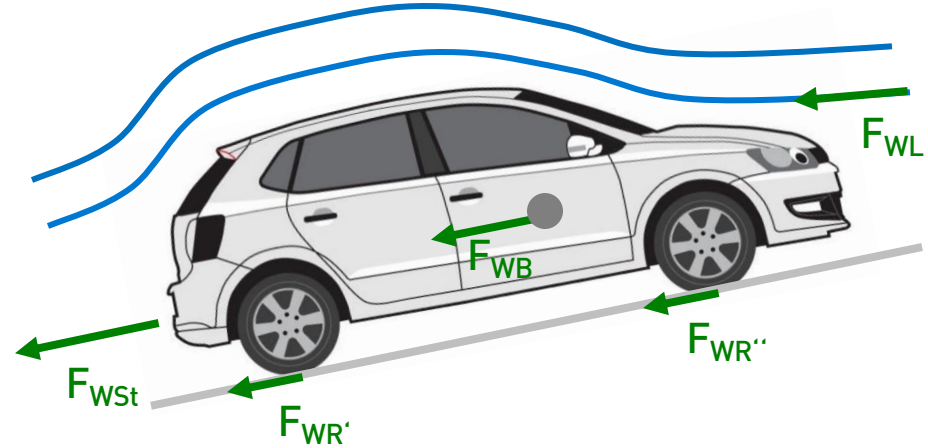
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HOCHSCHULE DARMSTADT  
UNIVERSITY OF APPLIED SCIENCES

# **Automotive Electrical Powertrain**

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# Driving Resistances



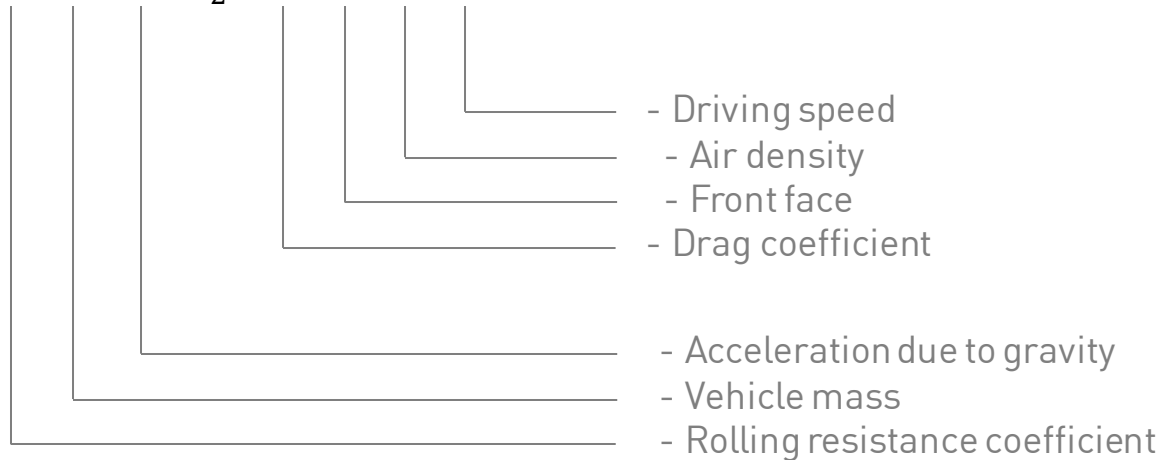
Various forces act against the movement of vehicles. The sum of these forces is called resistance to movement or total resistance  $F_W$ . In order to ensure propulsion the vehicle's drive must overcome these resistances.

# Driving Resistances

The movement resistance  $F_W$  is made up of the components rolling resistance  $F_{WR}$ , air resistance  $F_{WL}$ , gradient resistance  $F_{WSt}$ , acceleration resistance  $F_{WB}$ . When driving at constant speed on level ground with no wind, the normal driving resistance  $F_{W0}$  results from:

$$F_{W0} = F_{WR} + F_{WL}$$

$$= f_r \cdot m \cdot g + \frac{1}{2} \cdot c_w \cdot A \cdot \rho \cdot v_x^2$$



Berechnung des Fahrwiderstands

$$F_w = c_w * A_{proj} * \frac{\rho}{2} * (v_{Fzg} + v_{Wind})^2 + m * (1 + \lambda) * a + m * g * \sin(\alpha) + f_R * m * g$$

Berechnung der Antriebskraft

$$F_A = \frac{M_{Antrieb}}{r_{dyn}} = \frac{M_{Motor} * i * \eta}{r_{dyn}}$$

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# Zugkraft

Motormoment  
 $M_{mot}$

$$\frac{\eta_{A,total} \cdot i_{A,total}}{r_A}$$

$F_A$

Rollwiderstand  
 $F_{WR} = m \cdot g \cdot f_r$

Luftwiderstand  
 $F_{WL} = \frac{1}{2} \cdot c_w \cdot A \cdot \rho \cdot v^2$

Steigungswiderstand  
 $F_{WSt} = m \cdot g \cdot \sin(\alpha)$

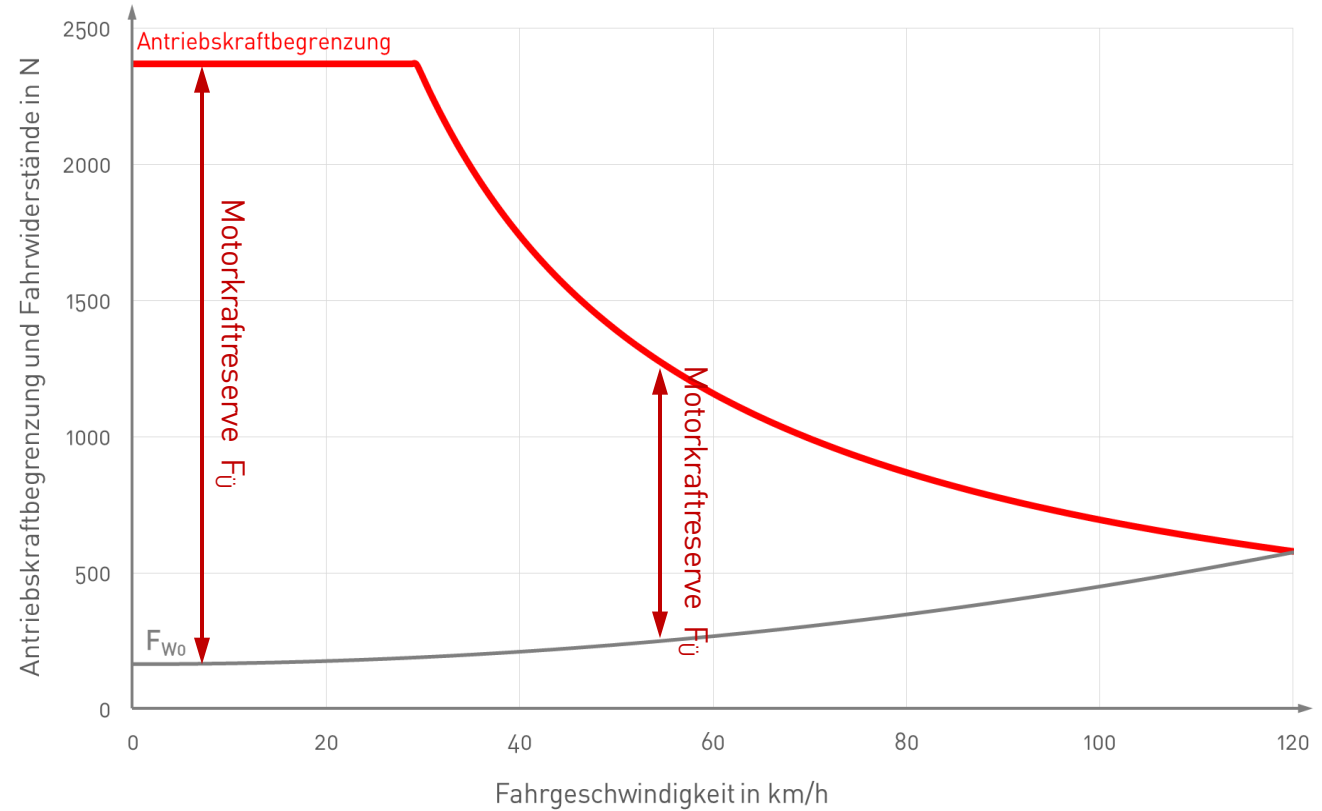
$F_{W0}$

$F_{\ddot{U}}$

$$\frac{1}{\xi \cdot m}$$

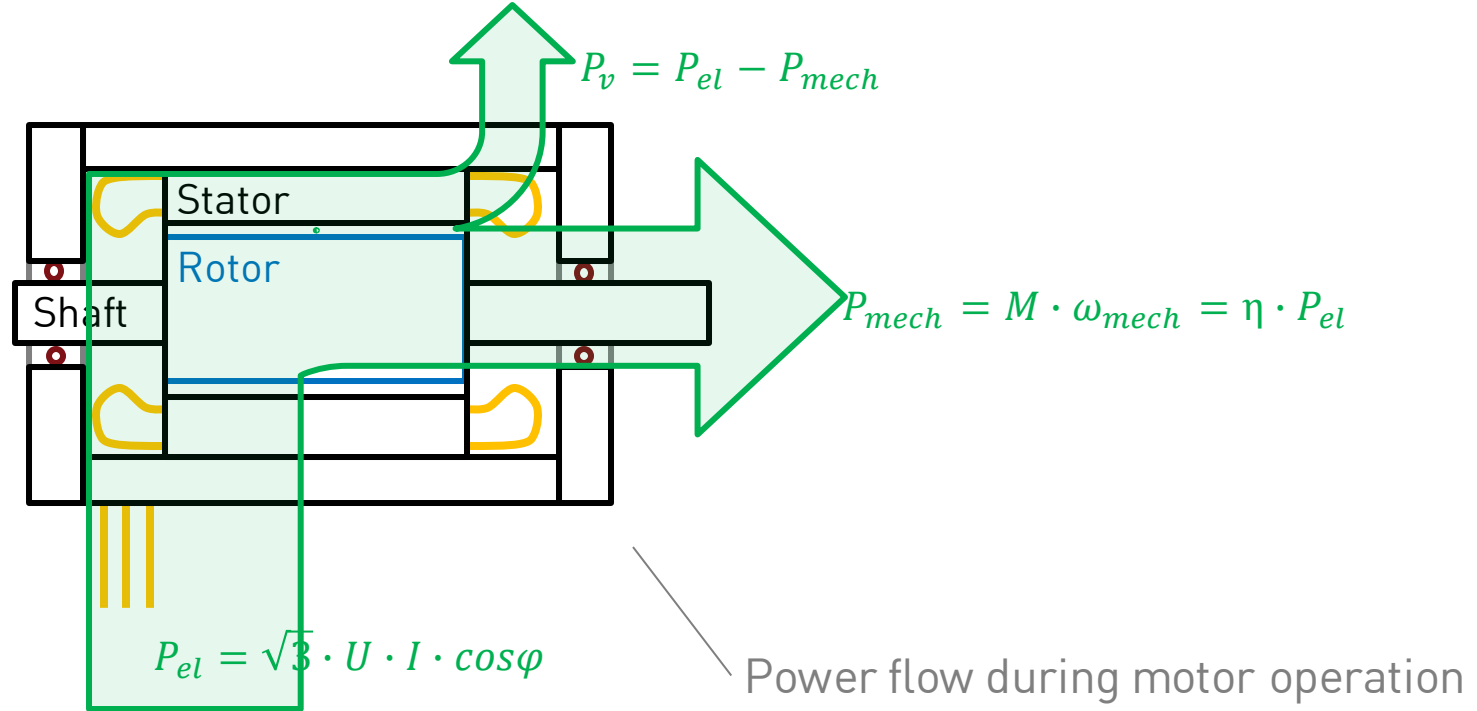
Beschleunigungs-  
vermögen  $a_x$

# Zugkraftdiagramm



# Power convention

Electric machines are, by their basic physical principle, electromechanical energy converters. They convert electrical energy into mechanical energy (motor operation).



## E-Motors and Energy Flow

