



**SPEAKER** MICHAEL ANDERSSON

**COMPANY** HÖGANÄS

**TOPIC** **POWER METAL GEARS FROM A  
SUSTAINABILITY PERSPECTIVE**

# Powder metal gears from a sustainability perspective

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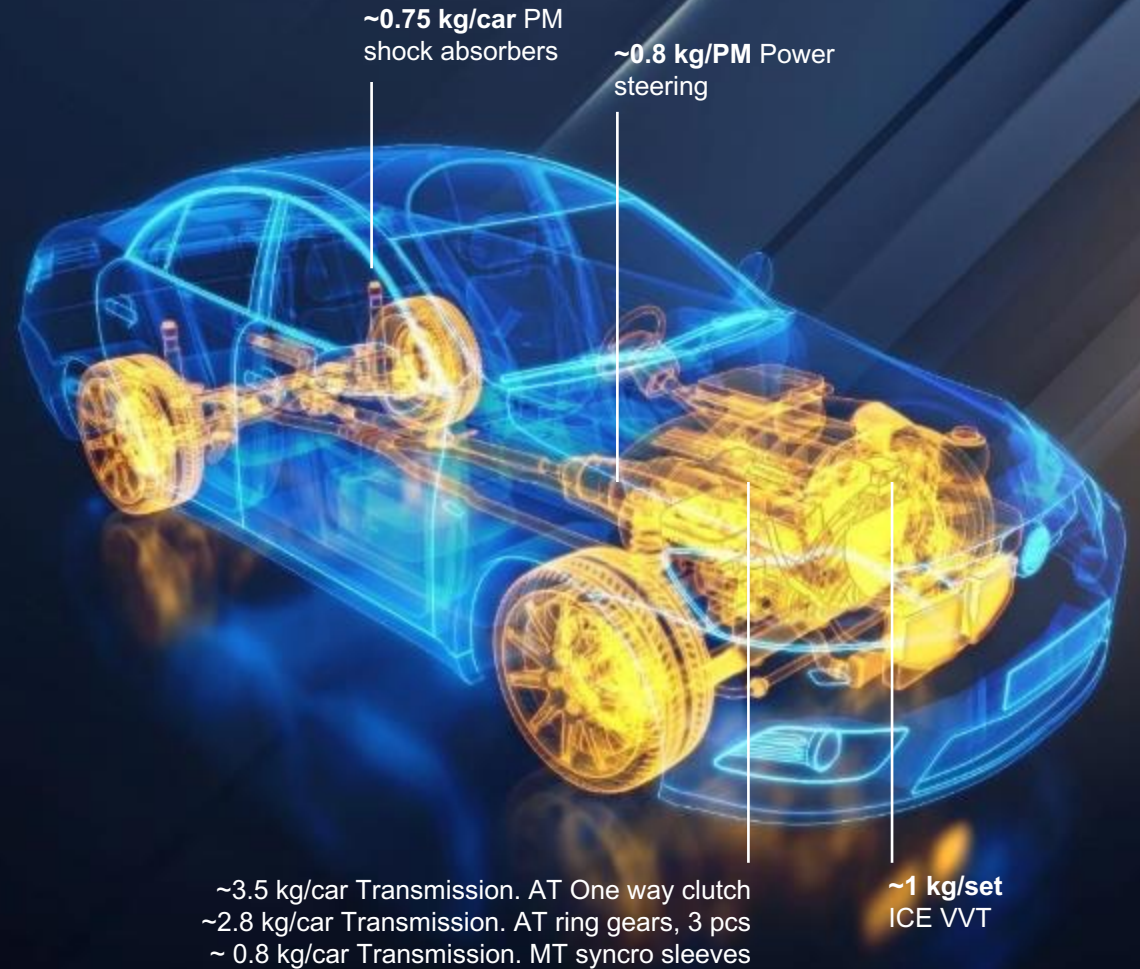
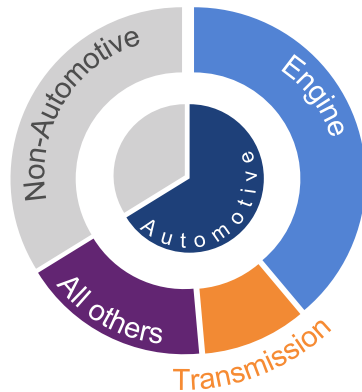
Alvier Mechatronics sustainability day 2023

Michael Andersson

# Höganäs' sintered applications

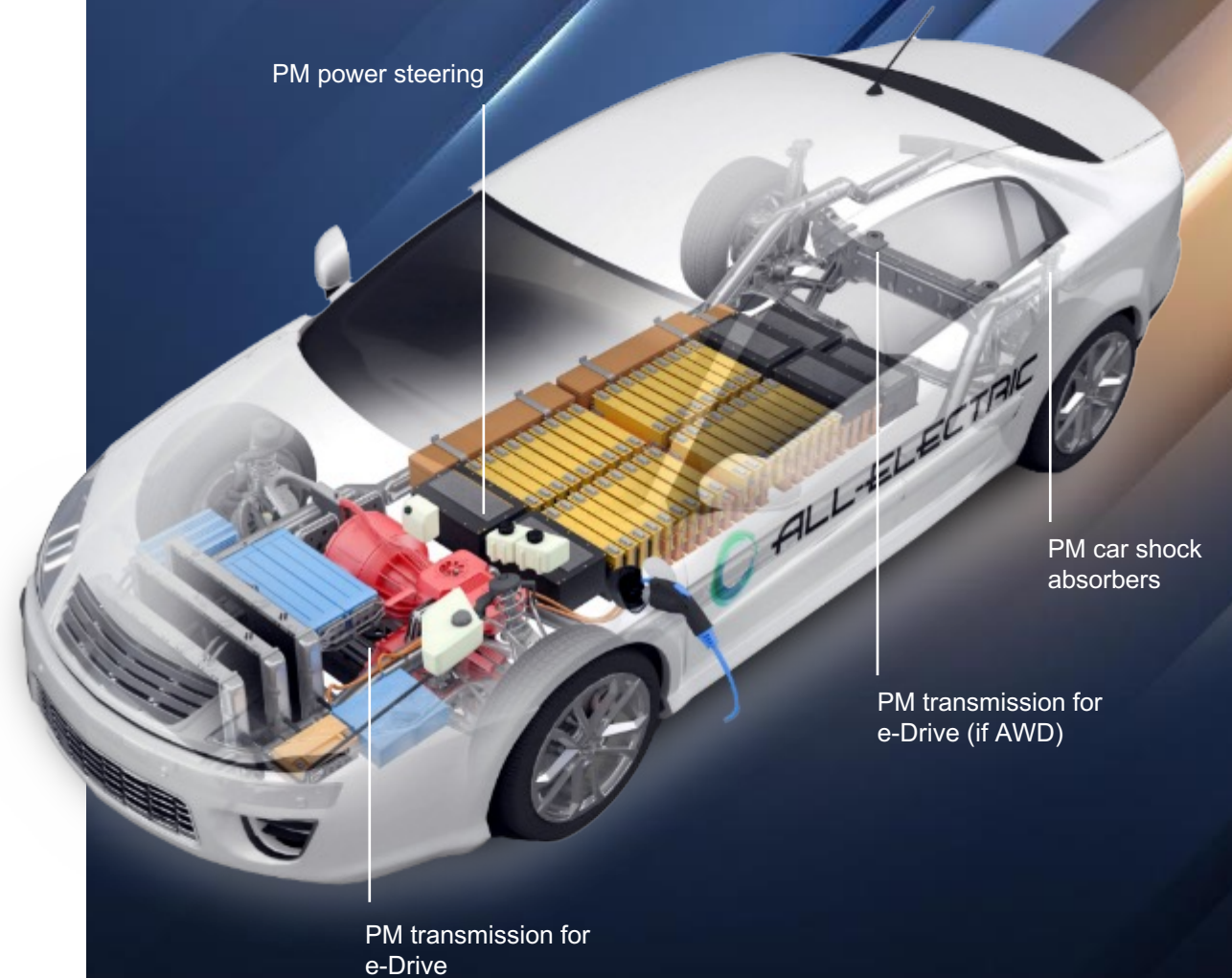
## 2/3 in automotive components

- » Predominantly for combustion engine and transmission components
- » Also in body & chassis and pumps & hydraulics

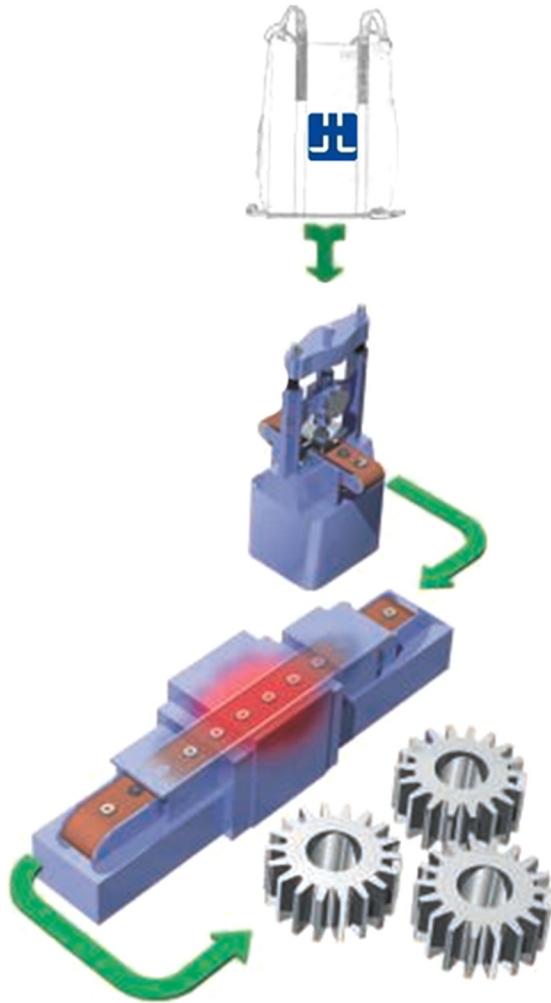


# Identified potential PM

Metal powder for electric vehicles

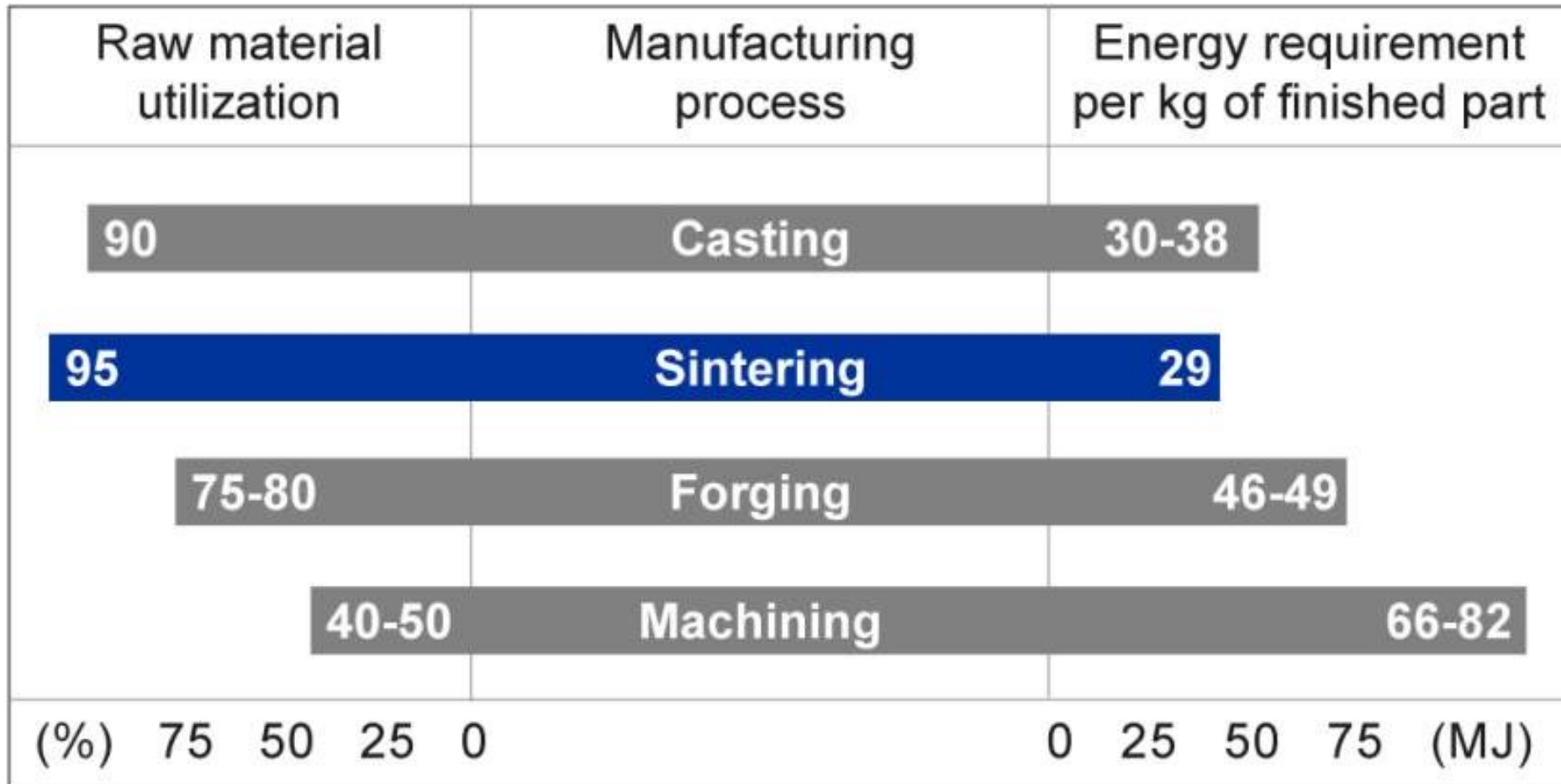


# The PM process (press and sinter)

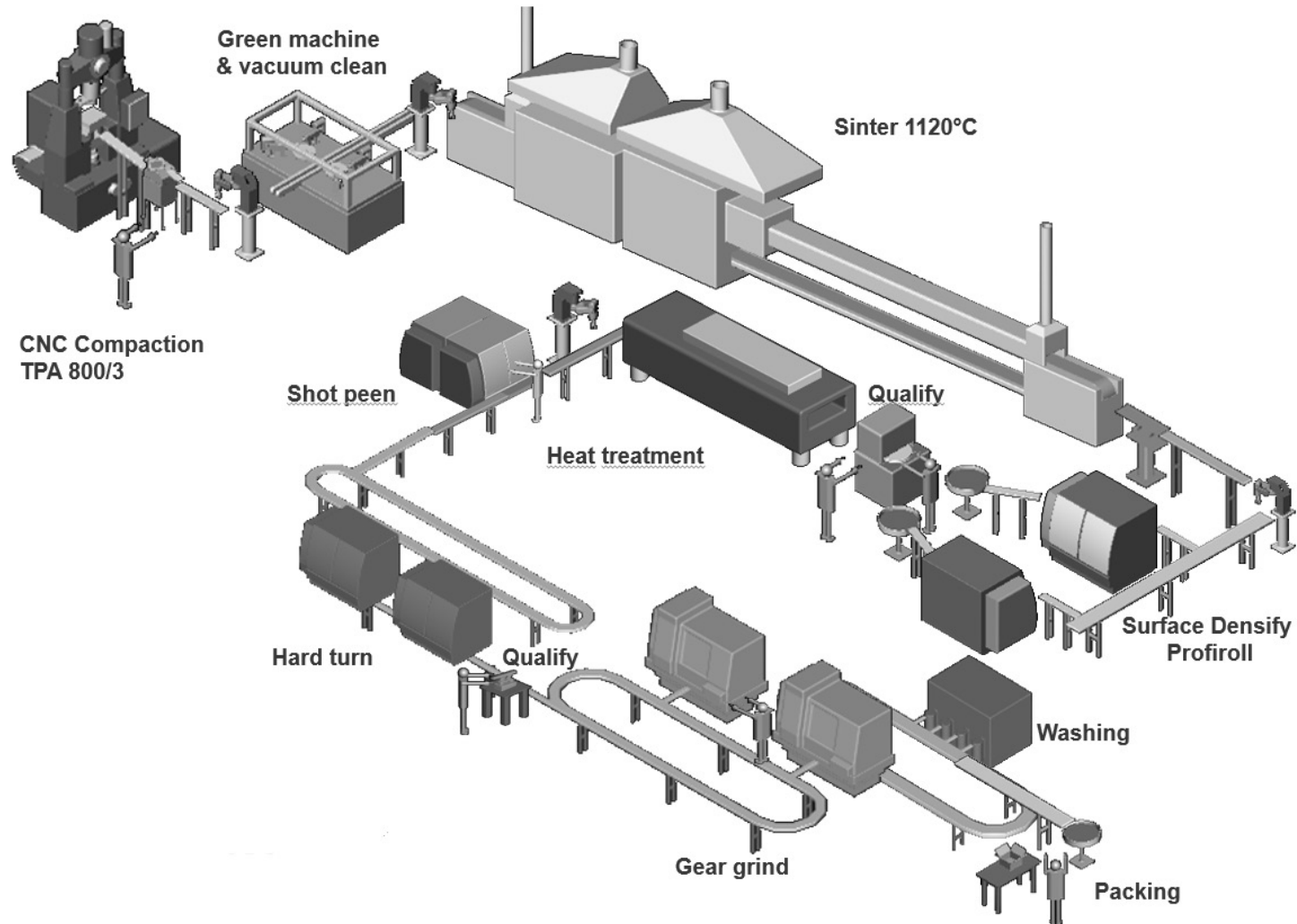


- » Lowest per unit cost in long series
- » Near-net shape with few process steps
- » Environmentally friendly process
- » Elimination of scrap
- » Tight tolerances
- » Broad range of alloy compositions with unique properties

# PM process advantages

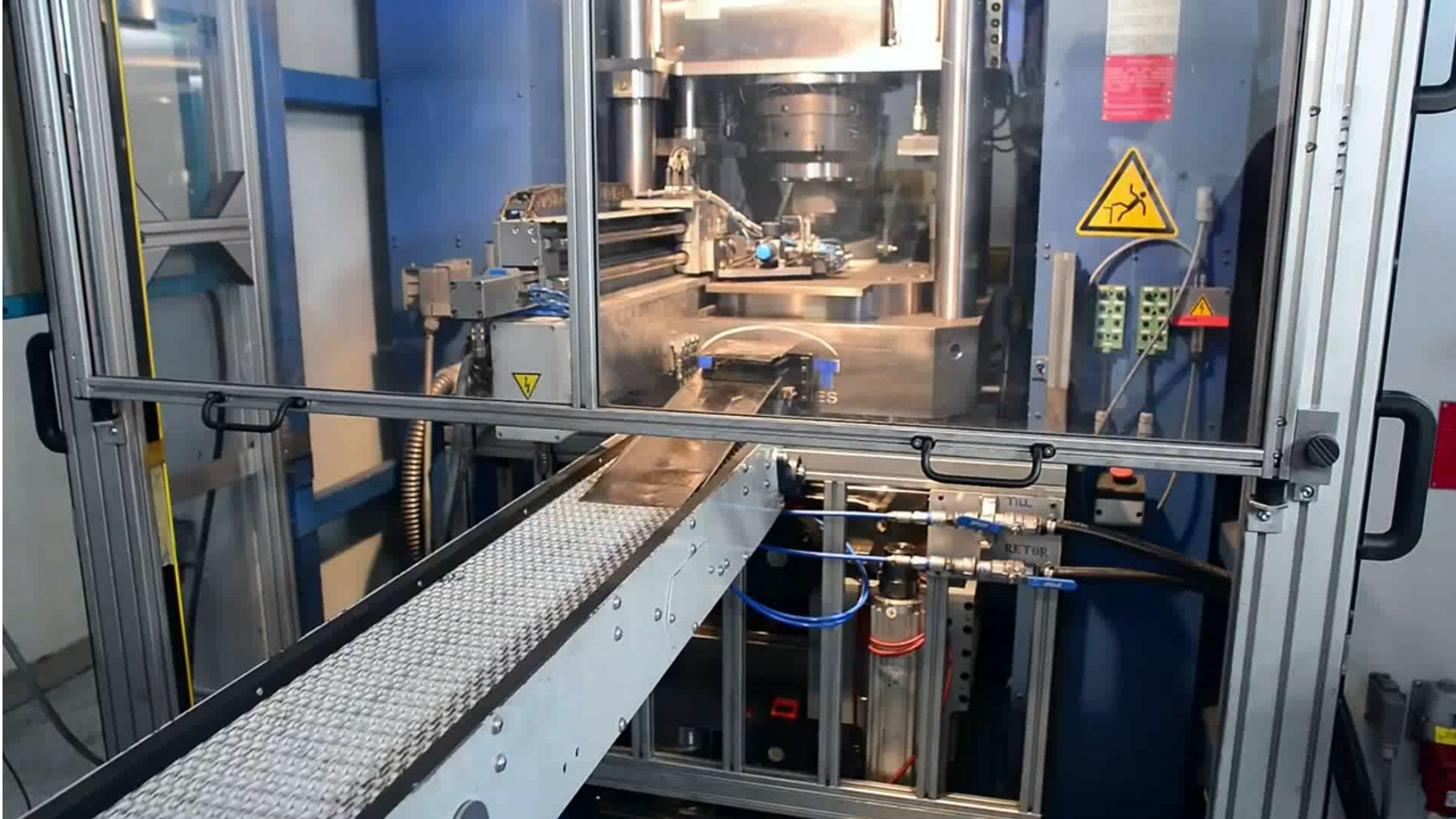


# Making a PM gear



# Compacting a PM gear

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# Cost and sustainability analysis

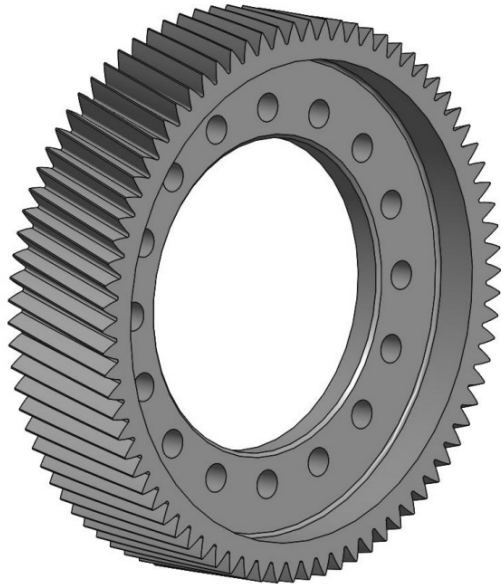
- » With POLARIXPARTNER
- » Cost and sustainability (CO<sub>2</sub>) calculation
- » Analysis for Germany, China and USA
- » Everything based on 2022 levels
- » Assuming mature manufacturing

The image shows a presentation slide and an Excel spreadsheet. The presentation slide is dark blue with the POLARIXPARTNER logo and the tagline "THE GUIDING STAR FOR THE MANUFACTURING INDUSTRY". Below the logo, it says "Alle Inhalte dieser Präsentation sind". The Excel spreadsheet is titled "polarixcosting - Calculation" and contains the following information:

<b>SW-Ver.:</b>	03.01.13
<b>File:</b>	TF-74 ALH0003_2Gears_sintered_V19.xlsb
<b>Author:</b>	Polarixpartner - TF
<b>Date:</b>	08-10-22
<b>Confidentiality:</b>	Confidential - Only distribute to designated recipients.

The Excel spreadsheet also shows a navigation bar at the bottom with tabs for "Start", "Supplier Definition", "System Definition", "System Summary", "System Details", "System Docu", and "Comp...". The status bar at the bottom indicates "Ready" and "Accessibility: Investigate".

# Reference case: Tesla Model S transmission



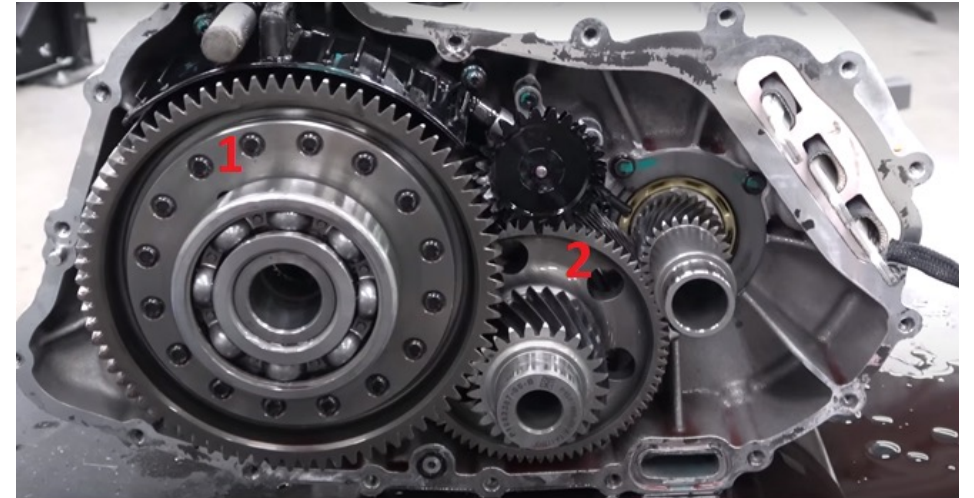
## 1. Final drive gear

- »  $m=3.9$  kg
- »  $\varnothing d_a=214$  mm
- »  $b=50$  mm



## 2. Intermediate gear

- »  $m=2.4$  kg
- »  $\varnothing d_a=146$  mm
- »  $b=44$  mm



# Intermediate gear CO<sub>2</sub>eq comparison, EMEA

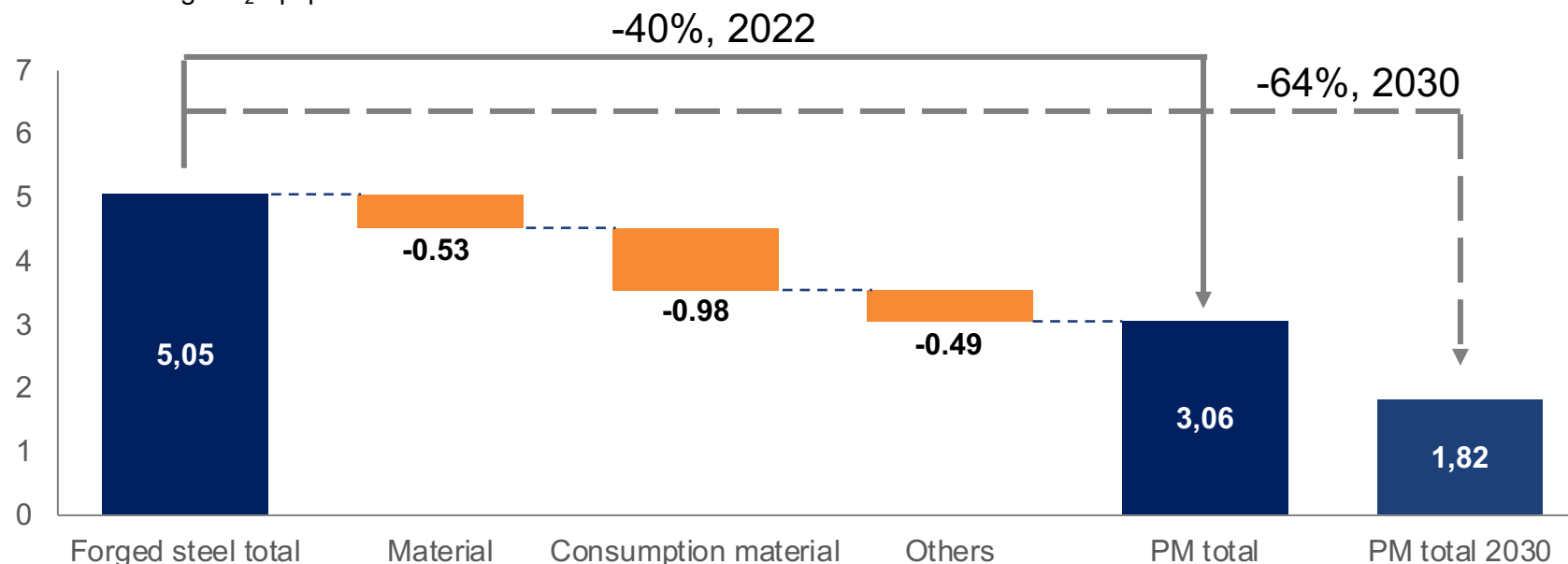
## Input Parameters



Calculated by	POLARIXPARTNER
Year	2022
Volume p.a.	100,000 pcs
Batch size	8,333 pcs
Lifetime	7 years
Supply chain	Germany
Weight (Forged gear)	2.4 Kg
Size	Øa: 146.1m Width: 44mm

## Forged vs PM Manufacturing

All values in kg CO<sub>2</sub>eq / part



<p><b>Material:</b> Forged steel, 16MnCr5, PM, Astaloy Mo</p>	<p><b>Consumption material:</b> Including electricity, natural gas etc.</p>	<p><b>Others:</b> Including area, operator, setup, overhead etc.</p>	<p><b>PM total 2030:</b> Only change the material CO<sub>2</sub>eq from 2022 to 2030, based on Höganäs sustainability roadmap</p>
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# Intermediate gear CO<sub>2</sub>eq comparison, APAC

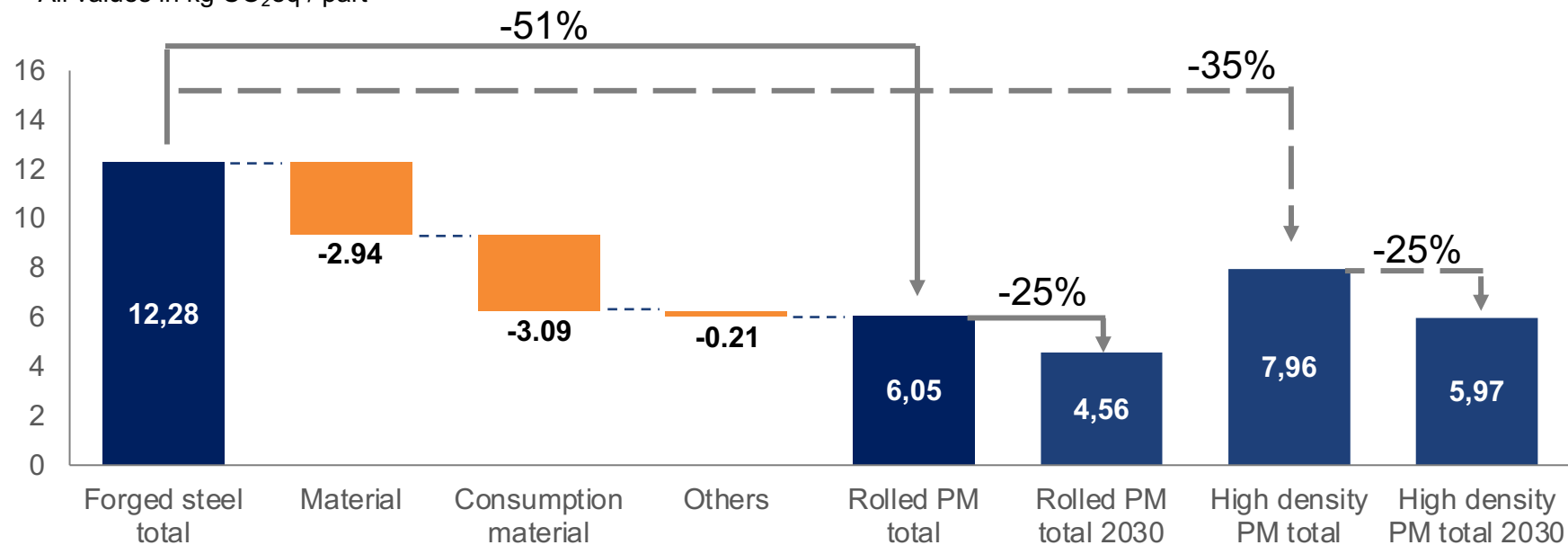
## Input Parameters



Calculated by	POLARIXPARTNER
Year	2022
Volume p.a.	100,000 pcs
Batch size	8,333 pcs
Lifetime	7 years
Supply chain	China
Weight (Forged gear)	2.4 Kg
Size	Øa: 146.1m Width: 44mm

## Forged vs PM Manufacturing

All values in kg CO<sub>2</sub>eq / part



<p><b>Material:</b> Forged steel, 16MnCr5 PM, Astaloy Mo</p>	<p><b>Consumption material:</b> Including electricity, natural gas etc.</p>	<p><b>Others:</b> Including area, operator, setup, overhead etc.</p>	<p><b>PM total 2030:</b> Only change the material CO<sub>2</sub>eq from 2022 to 2030, based on Höganäs sustainability roadmap</p>
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# Intermediate gear CO<sub>2</sub>eq comparison, USA

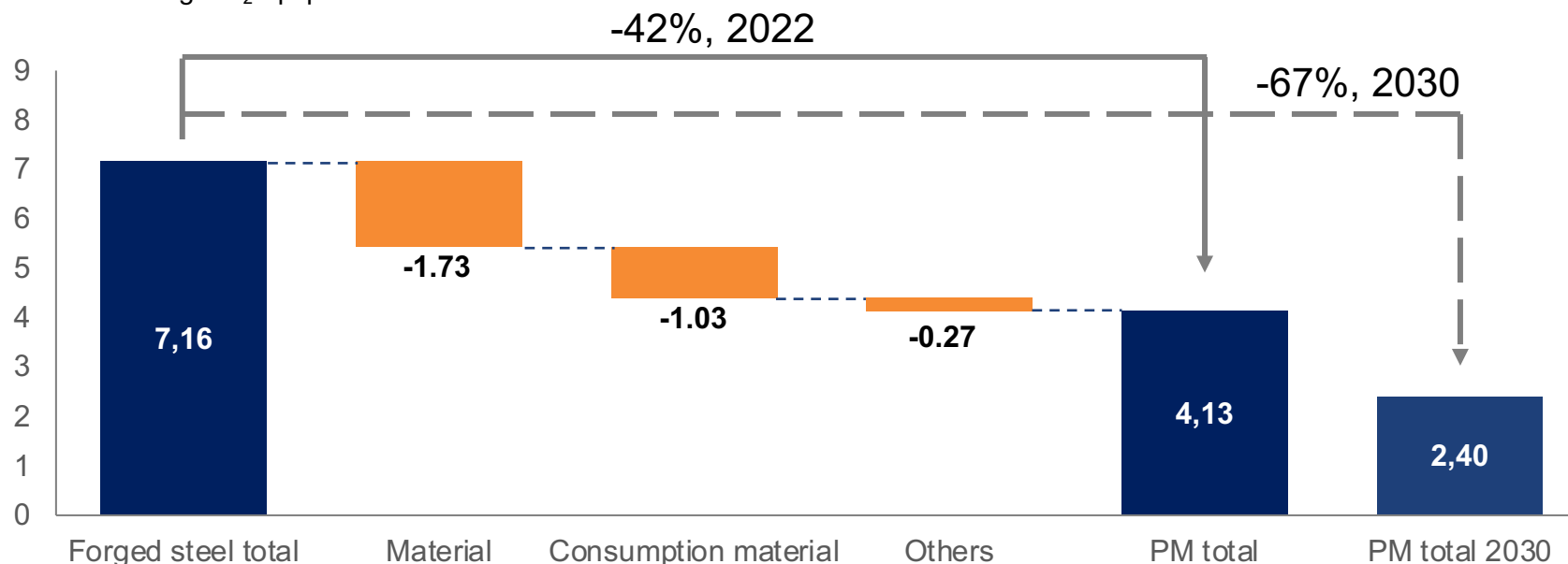
## Input Parameters



Calculated by	POLARIXPARTNER
Year	2022
Volume p.a.	100,000 pcs
Batch size	8,333 pcs
Lifetime	7 years
Supply chain	USA
Weight (Forged gear)	2.4 Kg
Size	Øa: 146.1m Width: 44mm

## Forged vs PM Manufacturing

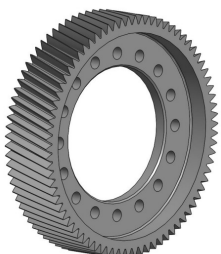
All values in kg CO<sub>2</sub>eq / part



<p><b>Material:</b> Forged steel, 16MnCr5, PM, Astaloy Mo</p>	<p><b>Consumption material:</b> Including electricity, natural gas etc.</p>	<p><b>Others:</b> Including area, operator, setup, overhead etc.</p>	<p><b>PM total 2030:</b> Only change the material CO<sub>2</sub>eq from 2022 to 2030, based on Höganäs sustainability roadmap</p>
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# Final drive gear CO<sub>2</sub>eq comparison, EMEA

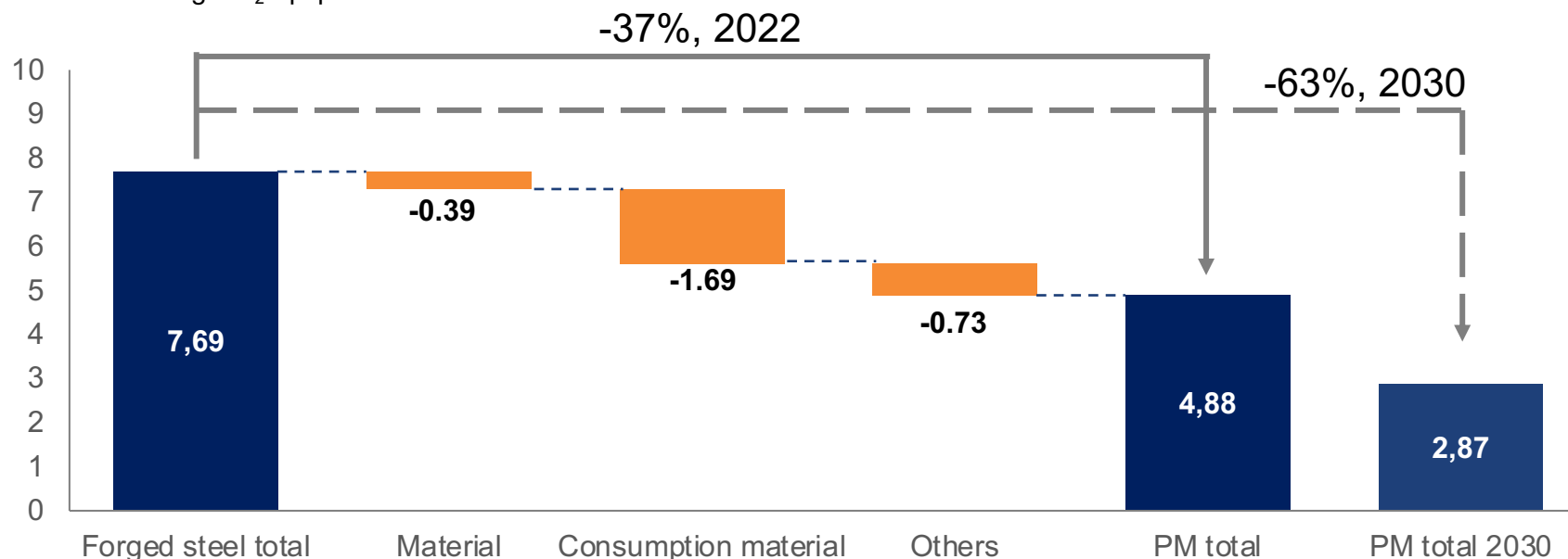
## Input Parameters



Calculated by	POLARIXPARTNER
Year	2022
Volume p.a.	100,000 pcs
Batch size	8,333 pcs
Lifetime	7 years
Supply chain	Germany
Weight (Forged gear)	3.9 Kg
Size	Øa: 214mm Width: 50mm

## Forged vs PM Manufacturing

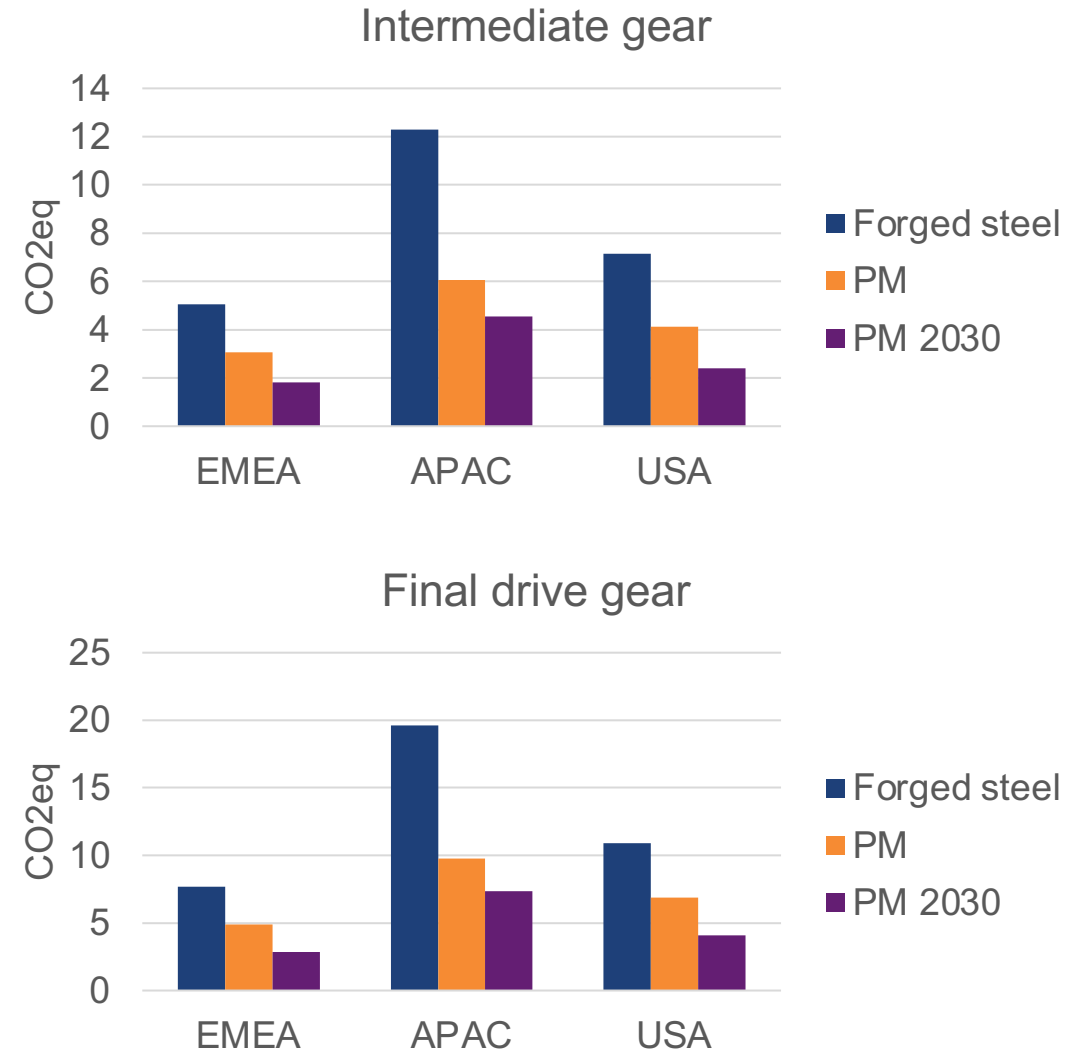
All values in kg CO<sub>2</sub>eq / part



<p><b>Material:</b> Forged steel, 16MnCr5, PM, Astaloy Mo</p>	<p><b>Consumption material:</b> Including electricity, natural gas etc.</p>	<p><b>Others:</b> Including area, operator, setup, overhead etc.</p>	<p><b>PM total 2030:</b> Only change the material CO<sub>2</sub>eq from 2022 to 2030, based on Höganäs sustainability roadmap</p>
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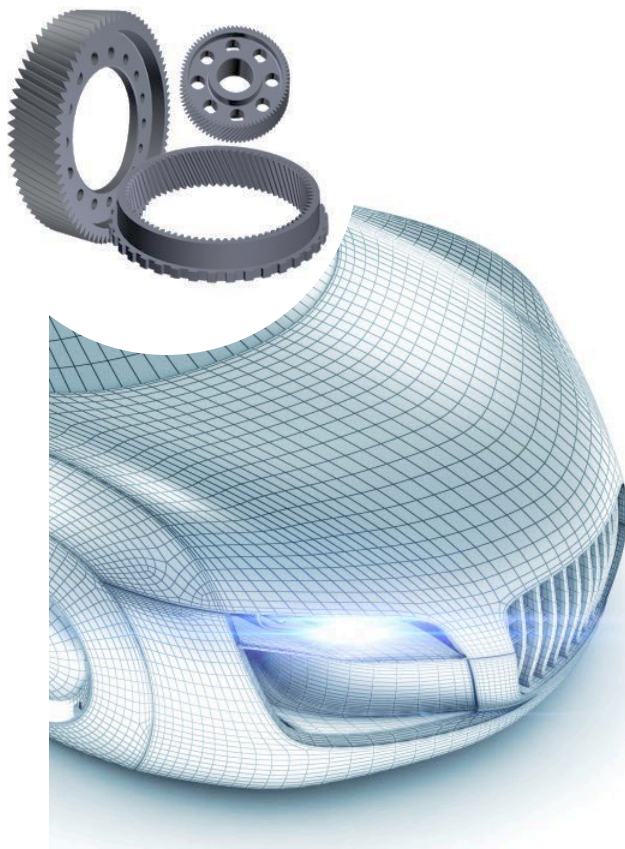
# CO<sub>2</sub> analysis – summary

- » All regions show large potential for CO<sub>2</sub> savings with PM gears
- » Energy efficient
- » High material utilization



# Advantages of powder metal gears for e-mobility

Compared to forged gear manufacturing process, powder metal gears offer:



**CO<sub>2</sub> emission reduction, up to 50%**

- Sustainable recycled raw material
- Reduced total energy consumption, app. 50%
- Reduced CO<sub>2</sub>eq, up to 1.5 kg CO<sub>2</sub>eq / kg part



**Cost effective manufacturing, up to 20% saving**

- Near net shape manufacturing
- High material utilization, app. 98%
- Lowest Total Cost



**Identified technical advantages**

- Improved dimensional consistency
- Weight reduction, up to 15%
- Still match forged steel strength

\* The total CO<sub>2</sub>eq depends on gear requirements, scrap content of raw material source, CO<sub>2</sub> footprint of production energy and location. Data in 2022



# Thank you!

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