GERMANY: PROGRESS ON AUTONOMOUS AND CONNECTED DRIVE TECH.

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Stefan Di Bitonto
Senior Manager Investor Consulting
Transportation Technology

stefan.dibitonto@gtai.com
www.gtai.com
Outline

1. Executive Summary
   a) The Industry in numbers
   b) The Premium Segment

2. Market Trends
   a) Overview of Market Trends
   b) Disruptors in Automotive Industry
   c) Autonomous and Connected Car Technologies

3. GTAII - Investor Support
   a) Who we are
   b) What we do
1. EXECUTIVE SUMMARY
Turnover in the Automotive Industry

Germany’s automotive industry turnovers exceeded 400 billion EUR

Turnover of the German Automotive Industry in Germany
(in billion EUR)

Total turnover of EUR 404.6 billion

High export share: EUR 256.3 billion generated in foreign markets.

79% of the industry’s turnover (EUR 317 billion) is generated by the OEMs

Source: VDA (2017)
Germany’s Automotive Market Size
Germany is Europe’s largest automotive market

Passenger car production in Europe 2016 (in million units)

Passenger car registrations in Europe 2016 (in million units)

Increase of passenger car production numbers in Germany in 2016: +0,2%

*Number one market by production and sales*, accounting for over 33% of all passenger cars produced in Europe

Increase of passenger car registration numbers in Germany in 2016: +4,5%

*Number one market by car registrations*, accounting for over 22% of all newly registered passenger cars in Europe

Sources: ACEA (2017); OICA (2017)
Industry R&D Investments
German automotive industry is the leading innovator

Internal R&D investments in Germany within the industrial sector (2015, in billion EUR)

- Automotive Industry: 21.7 billion EUR (35%)
- Remaining Industry Sectors: 40.7 billion EUR (65%)

R&D expenditures of the German automotive sector account for **35% of industrial R&D spending & increased by 10%**

Germany is world leader in auto industry patents: German OEMs account for more than **1/3rd of the world’s auto R&D**

**110,000 highly skilled engineers** work on automotive-related R&D-topics in Germany (+10% increase to 2015)

Sources: GTAI Research (2016), VDA (2017), Stifterverband (2016)
The Premium Segment
Germany: World’s premium car production and innovation hub

The country’s strong industrial base, its value chain density, its R&D power and particular strength in the automotive premium business, enables investors to develop cutting edge automotive technologies for today’s automotive needs. [...]”

Sources: GTAI Research (2017); MarkLines database (2017)

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2. MARKET TRENDS
# Mega trends in the automotive industry

Efficient and connected cars

<table>
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<th>KEY ISSUES</th>
<th>KEY TRENDS</th>
<th>SOLUTIONS</th>
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<td>ENVIRONMENTAL ISSUES</td>
<td>ICE DOWNSIZING</td>
<td>Battery electric mobility</td>
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<tr>
<td>“Fuel efficiency and environmental friendliness rated as most important product issues.”</td>
<td>ELECTROMOBILITY</td>
<td>Fuel cell electric mobility</td>
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<tr>
<td>URBANIZATION</td>
<td>INNOVATIVE URBAN CAR DESIGN CONCEPTS</td>
<td>Innovative urban vehicle design concepts</td>
</tr>
<tr>
<td>“Congestion and limited parking space are major concerns in megacities.”</td>
<td>CONNNECTED CAR CONCEPTS / AUTONOMOUS DRIVING</td>
<td>Connected car concepts</td>
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<tr>
<td>DIGITALIZATION &amp; CHANGING CUSTOMER BEHAVIOR</td>
<td>OEM CAPTIVE FINANCING, LEASING, AND PAY PER USE</td>
<td>OEM captive financing and leasing</td>
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<td>“Customers expect the same services when in the car as they receive at home, at work or on their smartphones.”</td>
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<td>Mobility services</td>
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<tr>
<td>“The world is moving from asset owned to asset shared business models.”</td>
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</table>

Source: KPMG’s Global Auto Executive Survey (2012); GTAI Research (2016)
Miles will Matter in the Future
New definition of the business model

Traditional business model

80 million vehicles \times 20,000 \$/car = 1,6 trillion $

Silicon Valley approach

1 billion existing vehicles \times 10,000 miles per year \times 1 $ per mile = 10 trillion $

Sources: A. Jonas, Morgan Stanley (2016); GTAI Research (2016)
National Strategy – Automated & Connected Drive
National strategy with five central action fields

- **Foundation**: Set up by the Federal Ministry of Transport and Digital Infrastructure in 2013
- **Involved Parties**: Experts from the fields of politics, R&D, insurance industry, vehicle manufacturer and suppliers
- **Main Target**: Development of strategic implications to answer the numerous individual legal and economic aspects related to automated driving

**Strategy development based on work results**

**Ongoing advancement & exchange**

**Goal**

- **Remain Leading Technology Provider**
- **Become Lead Market**
- **Enable automated and connected drive**

**Potential**

- **Increase of transport efficiency & quality**
- **Increase of transport safety**
- **Reduction of mobility-related emissions**
- **Reinforcement of Germany as business location**

**Action Fields**

- **Infrastructure**
- **Law**
- **Innovation**
- **Connectivity**
- **IT-Security**

Source: Federal Ministry of Transport and Digital Infrastructure; GTAI Research
Automated Drive Landscape
Digital Test fields and national automotive R&D & industry

Three different test fields enabled for autonomous and automated driving

Initiator:
• Federal Ministry of Transportation and Digital Infrastructure; State Ministries Baden-Württemberg and Lower-Saxony

Extract Test fields:
• Bavaria: Automated driving on the Autobahn A9 – Real time measurement of dynamic data; for more safety and better traffic flow
• Baden-Württemberg: Autonomous and automated action field Karlsruhe; urban and rural areas will both be tested
• Lower-Saxony: Approximately 270 km length between Hanover, Brunswick, and Salzgitter by 2018

Target:
• Testing, evaluating & improving mobility 4.0 technologies

Source: Federal Ministry of Transport and Digital Infrastructure; Federal Ministry of Economic Affairs and Energy; GTAI Research
Digital Testfield Autobahn (A9)
Germany: Test Area in Bavaria (Federal level)

Testing:
• Enabling testing for self driving, highly automated vehicles (level 3)
• Newly developed HD Map
• 5G car-to-car real-time communication standard
• Extraction of real-time data

New Traffic Sign:
• On Autobahn A9 between Ingolstadt and Munich
• Not ment for drivers
• Serves as orientation landmark for automated cars

Incentives for Investors Guidline:
• Focus lies on innovative infrastructure elements to enhance testfields
• No deadlines for submission
• However, projects must be completed no later that end June 2019

Sources: Federal Ministry of Transport and Digital Infrastructure
Test Area For Automated Driving Karlsruhe
Germany: Test Area in Baden-Württemberg (State level)

• Baden-Württemberg is strengthening its position in transportation and the automotive industry towards autonomous and connected driving.

### Operational Fields

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<th>Vehicles &amp; Infrastructure</th>
<th>Business Models &amp; Mobility Concepts</th>
<th>Legal Aspects &amp; Validation</th>
<th>Social Acceptance</th>
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### Application Areas

| Automated Commercial Vehicles: public shuttle & bus transport, logistics & supplier operation | Automated Passenger Cars: car sharing, commuting traffic, individual transport, micro mobility | Services: mobility apps and services |

*Sources: e-Mobil BW*
Test Track for Autonomous Driving
Germany: Test Area in Lower-Saxony (State level)

• Niedersachsen’s automotive sector leads Europe on automotive digitalization for autonomous driving

• On the Lower-Saxony test track, new technologies are being tested in real driving conditions. Unique within Europe.
  • Open research platform
  • 280 Km test track (highways, freeways, and urban traffic conditions)

• The project is led by the State of Lower-Saxony and the transport research department of the German Aerospace Center (DLR)

Sources: State of Lower-Saxony, DLR
Automated Drive Roadmap
Unified agreement about the process towards the autonomous car

- **Level 0**: Driver carries out all lane holding and lane changes. No inventing vehicle systems.
- **Level 1**: Driver carries out all lane holding OR lane changes. System handles the other function.
- **Level 2**: Driver must continuously monitor the system. System handles lane holding and lane changes in a special application case.
- **Level 3**: Driver needs no longer continuously monitor the system. Must be available to take over. System handles lane holding and lane changes in a special application case. Detects limits of system and asks the driver to take over with sufficient warning.
- **Level 4**: No driver necessary in special applications. System can handle all situations automatically in the specific case.
- **Level 5**: Fully Automated. System can handle all situations automatically throughout the trip. No driver needed.

**Legally permitted due to automated drive act (June 2017) resolved by German government to date**

Source: Federal Highway Research Institute; German Association of the Automotive Industry (VDA) 2015
Autonomous drive in Germany
German OEMs and suppliers are dominating autonomous drive innovations

Amount of patents related to autonomous drive technologies
(By different company groups and Top-10 patenting companies; 2010-2016)

*Disruptors, e.g. Google, Apple

Sources: PATENTSCOPE (2016); IW, Köln (2016)
4. GERMANY TRADE AND INVEST - SUPPORT
Who we are

Foreign trade and inward investment agency of the Federal Republic of Germany

Shareholder

Federal Ministry for Economic Affairs and Energy
What we do

International marketing of Germany as a business and technology location

Business location consultancy services for international investors

Economic promotion of the new federal states and Berlin

Export market information for the German economy
Advantages of the partner network

As the hub for a global network, we maintain close working relationships to a number of institutions.

- German Chambers of Commerce Abroad (AHKs)
- Chambers of Industry and Commerce (IHKs)
- Economic development agencies of the federal states
- German embassies and consulates
- Industry associations and lobby groups
- Multipliers
About GTAI Support
Two headquarters in Germany – 50 locations worldwide
Germany Trade & Invest serves as a one-stop consultant to the investing company

- Discussion on the market/industry and competition in Germany and Europe
- Information on tax and legal issues in Germany
- Information on different registration or licensing requirements
- Information on the financing of the project (including incentives)
- Discussion of location proposals/site evaluation incl. site visits
- Joint project management with regional economic development agencies
Velodyne LiDAR, Inc.
Automotive sensors and real time 3D data

Company profile (prior to investment)

- **About:** Velodyne was founded in 1983 as an audio company specializing in low-frequency sound and subwoofer technology. Starting in 2007, Velodyne expanded into LiDAR technology.
- **Industry:** Since 2007, Velodyne LiDAR has focused on applications of LiDAR technology for use in autonomous vehicles, vehicle safety systems, 3D mobile mapping, 3D aerial mapping and security.
- **Products:** Mainly LiDAR sensors. They are the most advanced in the market.

Project data

- Initial Investment: Approximately up to 100,000 Euro
- Location: Velodyne Europe GmbH in Rüsselsheim
- FTE’s: 20
- First contact with GTAI: January 2016
- Customer service center

Milestones

- **January 2016**  
  1. First contact with Velodyne at CES 2016, NV., USA
- **January 2016**  
  2. General information regarding Germany as a business location, and automotive hub
- **February 2016**  
  3. Meeting in Berlin with Erich Smidt, GF Dt.
- **March 2016**  
  4. Mediate to Hessen state agency
- **March 2016**  
  5. Transfer project to Hessen state agency

Impressions

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Thank you for your attention

Feel free to visit us at booth #307:

Mr. Stefan Di Bitonto
Senior Manager Investor Consulting
Transportation Technologies
T. +49 30 200 099 401
stefan.dibitonto@gtai.com