Automotive and Discrete Group

Marco Monti
President
Automotive and Discrete Group (ADG)
ADG addresses four end markets

- **Automotive**: 2019 ~70% of ADG revenues, 2020 YTD Q3 ~68% of ADG revenues
- **Industrial**: 2019 ~25% of ADG revenues, 2020 YTD Q3 ~28% of ADG revenues
- **Personal electronics**: 2019 ~5% of ADG revenues, 2020 YTD Q3 ~4% of ADG revenues
- **Communications equipment, computers & peripherals**: 2019 ~25% of ADG revenues, 2020 YTD Q3 ~28% of ADG revenues
Automotive and Discrete Group
Key financial figures

**2019 revenues**

- **$3.61B**
  - 2019 Net revenues

  - **ADG +1.5%**
    - 2019 vs. 2018
  - **ADG +8.6%**
    - CAGR FY’17-’19

**2020 YTD Q3**

- **$2.33B**
  - Net revenues

- **Automotive Product Sub-Group**
  - **$1.52B**
  - FY’19 Average
  - Q1 20, Q2 20, Q3 20

- **Power Discrete Sub-Group**
  - **$0.81B**
  - FY’19 Average
  - Q1 20, Q2 20, Q3 20

**ADG contribution to ST 2019 revenues**

38%
Q3 Automotive market pick up

2020 monthly light vehicle sales

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan20</th>
<th>Feb20</th>
<th>Mar20</th>
<th>Apr20</th>
<th>May20</th>
<th>Jun20</th>
<th>Jul20</th>
<th>Aug20</th>
<th>Sep20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mu</td>
<td>6.6</td>
<td>5.1</td>
<td>5.7</td>
<td>4.1</td>
<td>5.2</td>
<td>6.7</td>
<td>6.8</td>
<td>6.5</td>
<td>7.8</td>
</tr>
</tbody>
</table>

European xEV vehicles outperforming market growth

- H1 2019: 514
- H1 2020: 701

- BEV: +37%
- PHEV: +32%
- HEV: +30%

Automotive Product Sub-Group

- ‘20 Q3 vs ‘20 Q2 growth rate
  - +35%
  - +30%
  - +14%
  - +40%

ST is the only top 5 player growing stably in the past 2 years

CAGR 2017-2019

ST outperformed the 2019 market in electrification & ADAS

2019 Growth Rate

Smart Mobility trends
• Strong electrification trend in automotive and industrial markets
• Car connectivity, active safety and domain control drive the digitalization of the vehicles

Increasing semiconductor content
• Semiconductor pervasiveness in automotive
• Power semiconductors are a key enabler for automotive and industrial

Car sales under pressure
• Macro economic trends and consumer behavior

Deteriorated environment
• Pandemic and macro-economy trend deterioration pushed down 2020 car sales by 20% and strongly impacted factory automation
• Trade tensions increasing pressure in the supply chain

Car makers adapting
• Full autonomous driving projects postponed
• Tailwinds in ADAS L2 and L2++ increasing adoption
• Vehicle electrification is now mainstream at all car makers around the globe
ADG perspective and strategy evolution

**What has stayed the same**

- Company commitment to automotive and industrial
- Investments in technology innovation
- Commitment on power technologies in both traditional silicon and new materials
- Ambitions to lead in car electrification and digitalization
- Success in SiC with fast new program acquisition run-rate
- All key R&D programs on track, in spite of the pandemic

**What has changed after last CMD**

- Car sales softening leading to higher pressure on legacy automotive weakening group top-line
- Acceleration of the ongoing actions plan to better serve automotive macro-trends
- Expanded electrification programs based on SiC, IGBT, Microcontrollers, and Smart power solutions
- Accelerated partnerships in Asia for electrification including emerging players who are now leading
- Better ADAS volumes with pervasion of L2/L2++ more than compensating volume reduction
- Increased effort on GaN with acquisition to improve time-to-volume - complementing internal programs
Automotive market recovering

Short term global vehicle sales shows **V-shape** rebound

<table>
<thead>
<tr>
<th>Month</th>
<th>Low case</th>
<th>Mid case</th>
<th>Full year 2019 Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>65</td>
<td>72</td>
<td>85</td>
</tr>
<tr>
<td>2020</td>
<td>67</td>
<td>77</td>
<td>85</td>
</tr>
<tr>
<td>2021</td>
<td>79</td>
<td>84</td>
<td>89.1</td>
</tr>
<tr>
<td>2022</td>
<td>84</td>
<td>90</td>
<td>89.9</td>
</tr>
<tr>
<td>2023</td>
<td>88</td>
<td>94</td>
<td>94</td>
</tr>
</tbody>
</table>

Mid-term recovering better than expected

Light vehicle sales forecast

Source: LMC, IHS Automotive, ST Internal
Electric and assisted vehicle volume are growing despite light-vehicle market headwind

### Light vehicle production

<table>
<thead>
<tr>
<th></th>
<th>2019-2020 growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>xEV</td>
<td>+29% CAGR ‘20-'25</td>
</tr>
<tr>
<td>MHEV</td>
<td>+45% CAGR ‘20-'25</td>
</tr>
<tr>
<td>ICE</td>
<td>-3% CAGR ‘20-'25</td>
</tr>
</tbody>
</table>

### ADAS autonomous level pervasiveness

<table>
<thead>
<tr>
<th></th>
<th>2019-2020 growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>L0-L1</td>
<td>-20% CAGR ‘20-'25</td>
</tr>
<tr>
<td>L2+</td>
<td>+13% CAGR ‘20-'25</td>
</tr>
</tbody>
</table>

Source: IHS - Car production by propulsion system and Region - Sep.23.2020. ST internal

Source: IHS - Vehicle Production by Autonomy Level May 2020 forecast; ST internal
Automotive megatrends driving silicon pervasion

Automotive transformation boosting silicon value in the Car

<table>
<thead>
<tr>
<th>Year</th>
<th>2019</th>
<th>Auto Semi TAM</th>
<th>2023</th>
<th>Light vehicle semiconductor content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$36.6B</td>
<td>$45.1B</td>
<td>CAGR 19-23: 28.8%</td>
<td>Average semiconductor content per car [$]</td>
</tr>
<tr>
<td></td>
<td>+5.4% CAGR</td>
<td></td>
<td>4.7</td>
<td>ADAS: ~700$</td>
</tr>
<tr>
<td>ICE</td>
<td>4.7</td>
<td>4.1</td>
<td>5.9</td>
<td>Powertrain: ~400$</td>
</tr>
<tr>
<td>Hybrid</td>
<td>4.3</td>
<td>6.8</td>
<td>8.8</td>
<td>Infotainment &amp; Telematics:</td>
</tr>
<tr>
<td>BEV</td>
<td>3.1</td>
<td>5.7</td>
<td></td>
<td>Body &amp; convenience:</td>
</tr>
<tr>
<td></td>
<td>2.1</td>
<td></td>
<td></td>
<td>Chassis &amp; Passive Safety:</td>
</tr>
</tbody>
</table>

Increase Semiconductor content by level of Electrification

Increase Semi content by level of ADAS

Source: IHS - Automotive semiconductor market tracker - June-2020; ST internal
ADG automotive business evolution

Strong acceleration of transition to serve new mobility trends

ADG Automotive Revenues: 2.68B$ FY’19

- **35%** Digitalization & Electrification
- **65%** Traditional Automotive Core Electronics

Today

- ICE Engine Control
- Safety
- Car Audio

In less than 3 Years

- **>60%** Digitalization & Electrification
- **<40%** Traditional Automotive Core Electronics

- Car Electrification
- ADAS Vision
- Networking
- ADAS Radar
- Positioning & Connectivity

Projection shown at May 2019 Capital Markets Day

Strong acceleration of transition to serve new mobility trends
Key actions taken by ADG to accelerate the focus on new Automotive trends

1. Boost innovation in traditional automotive Smart Power
   - Transform **current portfolio** focusing on:
     - LED/OLED Drivers
     - EV - Battery management system
     - EV - Gate driver
     - Transmission & Steering
     - ADAS power management
     - Power Distribution 12-48V

2. Expand portfolio leveraging ST cutting-edge technologies
   - Product proliferation on **SiC**
   - Time to volume acceleration on **GaN**
   - Dedicated MCU for **RF-based ADAS**
   - **Stellar** roadmap expansion
   - **IGBT Trench** for mid-level inverters
   - **48V** hybrid solutions
   - Full system solution for **smart charging**

3. Focus on new macro trends, differentiating customer base
   - Redeploy smart power ASIC resources to **SiC, GaN and Low Voltage** for EVs and battery tools
   - Leverage BCD competence and resources to speed up **GaN development & deployment**
   - Boost **Asia support** with dedicated R&D team
   - Dedicated development support team for **new applications** leveraging competence centers

Move product R&D expenses progressively to new automotive trends

R&D for innovation
- The past...
- 2020

>60% of total 2020 R&D cost
Innovation in the traditional domain: Smart Power (BCD)

**Smart Power leadership In car electrification**

<table>
<thead>
<tr>
<th>Battery management system</th>
<th>Power distribution</th>
<th>Traction inverter &amp; on-board charger</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L9963 Family</strong> Scalable solutions from 48V up to 800V Best in class cells voltage accuracy</td>
<td><strong>L9678 &amp; L9679</strong> Battery cut-off &amp; fire-off disconnecting power line in case of emergency or crashes</td>
<td><strong>L950x Family</strong> SiC &amp; IGBT Isolated pre-driver up to 6kV for traction inverter, DC-DC &amp; OBC</td>
</tr>
<tr>
<td>In production</td>
<td>In production</td>
<td>In qualification</td>
</tr>
</tbody>
</table>

**ADAS and autonomous driving power management**

<table>
<thead>
<tr>
<th>Radar-based systems</th>
<th>Camera-based system</th>
<th>Autonomous driving L3/4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L5965S and STPM066S family</strong> Power management for radar system</td>
<td><strong>STPM80x family</strong> Integrated &amp; distributed power management solution for L2+ ADAS systems</td>
<td><strong>STPM020</strong> High current power management for powerful processors ASIL-D</td>
</tr>
<tr>
<td>Full production 2020</td>
<td>Production H1’22</td>
<td>In development</td>
</tr>
</tbody>
</table>
Digitalization and shared mobility boost silicon content

**ADAS L2 & L2++** acceleration trend supporting pervasion

NCAP Regulation (L2) boosting Si content for assisted driving system, increasing safety

<table>
<thead>
<tr>
<th>Year</th>
<th>L2 &amp; L2++ Share on Car Production</th>
<th>Increased Si/$ x Car</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>20%</td>
<td>+160 $</td>
</tr>
<tr>
<td>2025</td>
<td>&gt; 40%</td>
<td></td>
</tr>
</tbody>
</table>

**ADAS L4/L5** to support Robo-Taxi & Shared Autonomous Mobility increasing silicon value per car

High-value electronics for Autonomous Vehicles enable mobility-as-Service

Average silicon content per car

<table>
<thead>
<tr>
<th>Year</th>
<th>Average silicon content per car</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td>$5 K$</td>
</tr>
</tbody>
</table>

**SW reconfigurable vehicle: new car architecture**

Remote, seamless SW update needs new Vehicle Architecture

Computational Power x Car

<table>
<thead>
<tr>
<th>Computational Power x Car</th>
<th>Digital Silicon Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>x10</td>
<td>+30%</td>
</tr>
</tbody>
</table>

**Cloud connectivity for Big-Data harvesting**

Global Big Data from vehicles opens Service Company opportunities

| Vision & Telematics processors | +200 $ |

Source: data based on ST internal estimation
ST car digitalization portfolio matches market trends

ADAS L2 & L2++ acceleration trend supporting pervasion

- EyeQ4, EyeQ5L, EyeQ6L for L2+
- Radar MMIC
  - V2x Kit with Autotalks
  - 32-bit MCU for Radar

>54M units
of Intel Mobileye EYQx delivered on the market

ADAS L4/L5 to support Robo-Taxi & Shared Autonomous Mobility increasing silicon value per car

- EyeQ for Autonomous Driving
- TeseoV Precise Positioning
- 32-bit MCU automotive Tailored for ADAS

SW reconfigurable vehicle: new car architecture

- 32-bit 28 nm FD-SOI MCUs enabling Software isolation & Over-the-air SW updates

Cloud connectivity for Big-Data harvesting

- Telemaco3P cloud connectivity & telematics
Architecture migration increases MCU and smart power silicon content per vehicle

- Need for MCU with high computational power and specialized embedded memory for real-time operation & over-the-air SW update
- Increased ASP thanks to extended functionality
- 30% MCU TAM increase thanks to new architecture

- Protected switches require optimized power stage to manage mid/high current load
- High logic computation requirement to manage overload and hazard conditions during abnormal operation

ST estimations based on new vehicle generations from 2025 onwards
ST offer for architecture migration to domain/zone controller

**Stellar** 32-bit ARM Multicore Real-Time MCU
Verified and Selected by **Bosch** for next Gen Systems

- Simplify the execution of multiple software programs in hardware isolated “virtual” CPUs with peripherals firewalls
- Phase change memory enables cost effective OTA software updates with no interruption of software execution *but* without doubling the memory size

**ST Smart power for new architecture power distribution**

- New VIPower technology (M0-A11) the best choice for in-vehicle power grid
- Partnership with key market players to capture an important share of the 1B$ additional TAM

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Reference partner  
**BOSCH**

Leading Partner

Leading European Car maker
ADG system offer for electrified mobility – beyond SiC

Galvanic Isolated Drivers
- Galvanic isolated families of functional safety pre-drivers up to 6 kV isolation

Rectifier, Fast Diodes & AC Switches: TRIAC & SCR
- Extensive offer for multiple customer needs for On-board charger and Charging Pile

32-bit MCU for electrification
- Dedicated for power conversion system - entry-level electrification to Battery EV

Power Module
- Standard & Custom solutions for
  - Molded / Ceramic Modules
  - Air flow / Liquid cooling
- Partnership for SiC MOSFET/IGBT for Semikron power modules for electric vehicle traction inverter & high-end industrial

Low Voltage MOSFET
- Family covering 30 V ~ 150 V applications
- Specific target to 48 V hybrid mobility

IGBT & HV MOSFET
- Complementing SiC offer
- Broad range IGBT solution (600 V – 1700 V)

Electrification device types % value
- Power 62%
- Discrete 5%
- Other 26%
- MCU 7%
Power semiconductors are vital for automotive and industrial applications

Increasing power semiconductor contents in **automotive** applications

- **2020**
  - $3.8B
- **2024**
  - $7.9B

  2024 xEV Power TAM

  +20% '20-'24 CAGR

  +26% '20-'24 IGBT CAGR

  +47% '20-'24 SiC CAGR

Power semiconductor pervasiveness in key **industrial** applications

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Motor Drive</th>
<th>Transport</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020 Semi Power TAM</td>
<td>3.8</td>
<td>1.2</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>2020-24 CAGR</td>
<td>7.6%</td>
<td>5.0%</td>
<td>5.4%</td>
<td>10.8%</td>
</tr>
</tbody>
</table>

Source: IHS Automotive– June 2020; ST Internal

Source: Industrial Semiconductor Market Tracker – June 2020
Silicon & Wide-Bandgap material

Broad offer to cover power applications in automotive & industrial

Examples of power application coverage

- Traction inverter, DC-DC converters, motor control
- On-Board Charger, Lidar, 48V Hybrid
- Braking, conventional power train, mid power motor control
- Motor drives and energy conversion
- Energy storage
- Power supply, DC-DC / AC-DC converters, portable solutions
- Power tools, home appliances, battery operated tools

Switching power [kW]

Operating Frequency [Hz]

- Silicon: IGBT (300mm), MOSFETs (150mm, 200mm)
- SiC: 200mm
- GaN: 200mm

Manufacturing strategy
Continue to strengthen our SiC market leadership

Leading global supplier for Silicon Carbide
>50% market share
for SiC MOSFETs in automotive and industrial markets

Partnering with leading global players
with solutions already in production

Award rate acceleration
More than 68 projects in development:
~50% Industrial & ~50% in Automotive

Source: OMDIA power-semiconductor-market-share-database-2020-v3 - Sept. 2020; ST Internal
Silicon Carbide leadership differentiators

ST key differentiators in SiC

- Two manufacturing sites
- Silicon architecture with the best-in-the-market channel resistivity thanks to an optimized planar structure and dedicated EPI
- Strong synergy between R&D and Manufacturing
- Evolution planned with a trench structure but with a Super Junction approach

Manufacturing performance in line with silicon standard

20+ Years of R&D commitment
SiC manufacturing strategy for vertical integration

Substrate supply chain strategy: **Norstel 100% acquisition** pursuing vertical integration to support the **1B$ SiC revenue target by 2025**

- >40% production with internal substrate by 2024
- R&D investments to move to 200mm production

Internal **Substrate** production volume with an **additional manufacturing plant** with **200mm** compatible equipment for supply security and cost optimization
Accelerating our Gallium Nitride execution strategy

Partnerships and acquisitions to accelerate our GaN roadmap

**TSMC partnership**
A step forward in product development and epitaxy expertise for our long-term GaN roadmap, ecosystem and business

**EXAGAN majority stake acquisition**
Leveraging ST’s market expertise and TSMC foundry know-how to bring Power GaN & GaN ICs to market

ST to offer a full range of GaN-based power device solutions for all markets, including a wide range of normally-off products from 100 to 650 V housed in state-of-the-art packages

- Automotive and Industrial customers sampling in 2019
- 1st 650 V product Production ramp-up by end of 2020
- 1st 100 V product Production planned H2 2021
ST GaN: comprehensive strategy to support innovation, time-to-market and high volume

Full application coverage

- Solar Inverter
- Data center
- Server Power Supply
- Portable Adapter
- On-board Charger
- DC-DC Converter
- LiDAR
- Premium Audio

Optimized manufacturing strategy

- **External**
  Complement roadmap by partnering with TSMC to improve time-to-market and enable multi-site high volume

- **Internal**
  Targeting internal 200mm manufacturing in Tours leveraging proprietary technology (100V...650V)

Year:
- 2020
- 2021
- 2022
- 2023
- 2024
- 2025
IGBT: Leadership in fast growing industrial and automotive domains

**ST Ambition**

To become a leader in IGBT for automotive and industrial

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**ST IGBT**

Growth vs. the market 2019-2023

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**Innovation drives our market share gains thanks to tailored application focus**

**IH Series**
Soft switching applications

**HB2 Series**
Power Density solution

**MS Series**
Suitable for Motor Drive

**NMII Series**
Tailored for EV traction

- Induction Heating, Welding
- Solar, Energy Storage, OBC, Charging Station
- Car Air-Con, Inverter for Motor control
- EV Traction Inverter

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- Product offer based on **10 technology options** with ~600 products
- Plan to enrich the offer with an additional **6 Series by 2023**

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Growth rate comparison based on ST projection (award pipeline) and OMDIA/IHS, power-discrete-module-market-tracker-interim-2019
Continue growth in Industrial focusing on newer high-silicon content applications

Battery operated tools as a main driver of growth

Fast market growth driven by Silicon Low voltage (<150 V) MOSFET

~20% CAGR FY’19-'23

Served market

Vacuum cleaners
Power tools
Drones
Robots

Fast growth of ST’s latest low voltage MOSFET technology

ST STripFET

Broad product family of Low Voltage MOSFET

Source: IHS Industrial semiconductor Market Tracker Q3 2019, Tool Market estimated by Market data and ST Internal
ADG takeaways

• ADG is growing faster than the market in all application domains it addresses

• ST has anticipated the automotive market transformation and is focused on growing business in smart mobility applications, driven by electrification and digitalization

• Action has been taken to progressively move skills and R&D resources to enlarge our product portfolio and market coverage
  • Benefitting of strong internal know-how
  • Optimizing R&D cost vs market dynamics
Thank you