



# INVESTOR DAY

DECEMBER 2, 2016



# TODAY'S OBJECTIVES

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- **GIVE A GREATER INSIGHT INTO THE GROUP**
- **HIGHLIGHT MERSEN'S INNOVATION AND GROWTH OPPORTUNITIES**
- **DISCOVER MERSEN IN THE TRANSPORTATION MARKET**
- **MEET SOME OF OUR SENIOR MANAGEMENT**

# AGENDA

<b>9:00 – 9:30</b>	<b>Group's strategy</b>	<i>Luc Themelin</i>
<b>9:30 – 10:10</b>	<b>Mersen in the rail market</b>	<i>Gilles Boisseau</i>
<b>10:10 – 10:40</b>	<b>Mersen in aeronautics</b>	<i>Eric Guajioty</i>
<b>Break</b>		
<b>11:00 – 11:15</b>	<b>Innovate at Mersen</b>	<i>Christophe Bommier</i>
<b>11:15 – 12:15</b>	<b>3 case studies</b> San Francisco BART      Wireless Tramway      E-mobility	<i>Christophe Bommier</i> <i>Philippe Roussel</i>
<b>Quiz &amp; lunch</b>		



# GLOBAL EXPERT IN ELECTRICAL POWER AND ADVANCED MATERIALS

LUC THEMELIN, CEO



# MERSEN IN BRIEF

## SALES

€772 M\*

- 37 % AMERICAS
- 34 % EUROPE
- 29 % ASIA AND REST OF THE WORLD

\* 2015 data

\*\* 2016 Half-year figures

## STAFF

6,191\*\*

- PRESENCE IN 35 COUNTRIES

## LEADERSHIP POSITIONS

WORLD  
N°1 & N°2

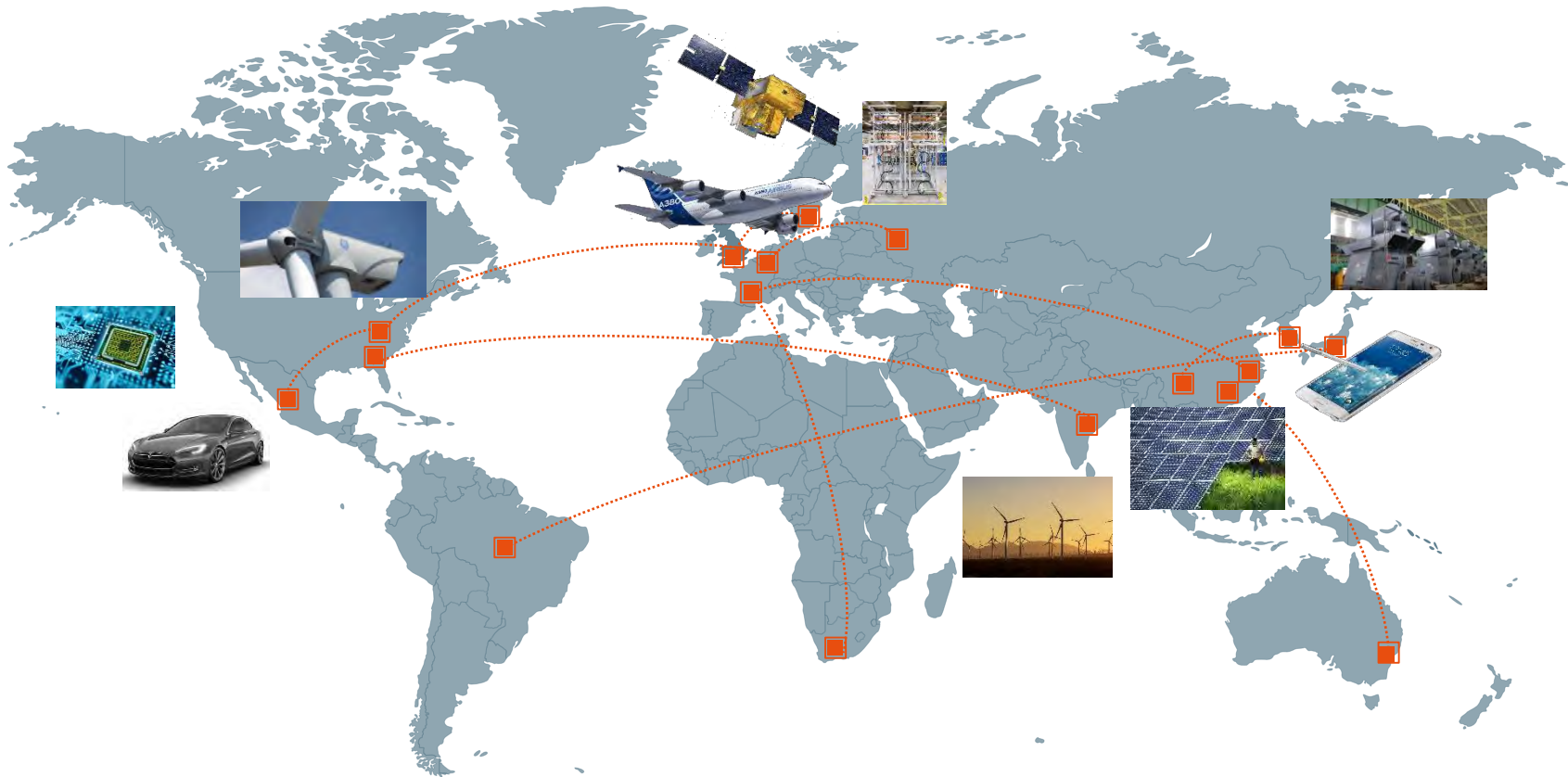
- GRAPHITE-BASED ANTI-CORROSION EQUIPMENT
- BRUSHES AND BRUSH-HOLDERS FOR INDUSTRIAL ELECTRIC MOTORS
- HIGH-TEMPERATURE ISOSTATIC GRAPHITE APPLICATIONS
- PASSIVE COMPONENTS FOR POWER ELECTRONICS
- INDUSTRIAL FUSES

# MERSEN: OUR MISSION

**WE DEVELOP  
THE BEST TECHNOLOGIES FOR  
THE INDUSTRIES OF THE FUTURE**



**WE PROVIDE INDUSTRIAL COMPANIES AROUND THE  
WORLD WITH INNOVATIVE SOLUTIONS ENHANCING THE  
PERFORMANCE OF THEIR PRODUCTS AND SERVICES**



# LEADERSHIP POSITION ON OUR 2 EXPERTISES ...

~ 60% SALES

~ 40% SALES

## ADVANCED MATERIALS

ANTICORROSION  
EQUIPMENT



GRAPHITE  
SPECIALTIES



POWER TRANSFER  
TECHNOLOGIES



GLOBAL  
PRESENCE

LEADERSHIP  
POSITIONS

15-30% MARKET  
SHARES

CUSTOMIZED  
SMALL SERIES

STRONG  
EXPERTISE

HIGH  
VALUE-ADDED

## ELECTRICAL POWER

ELECTRICAL  
PROTECTION  
& CONTROL



SOLUTIONS FOR  
POWER  
MANAGEMENT



## ... WITH FINANCIAL COMPLEMENTARY MODEL

### *ADVANCED MATERIALS*

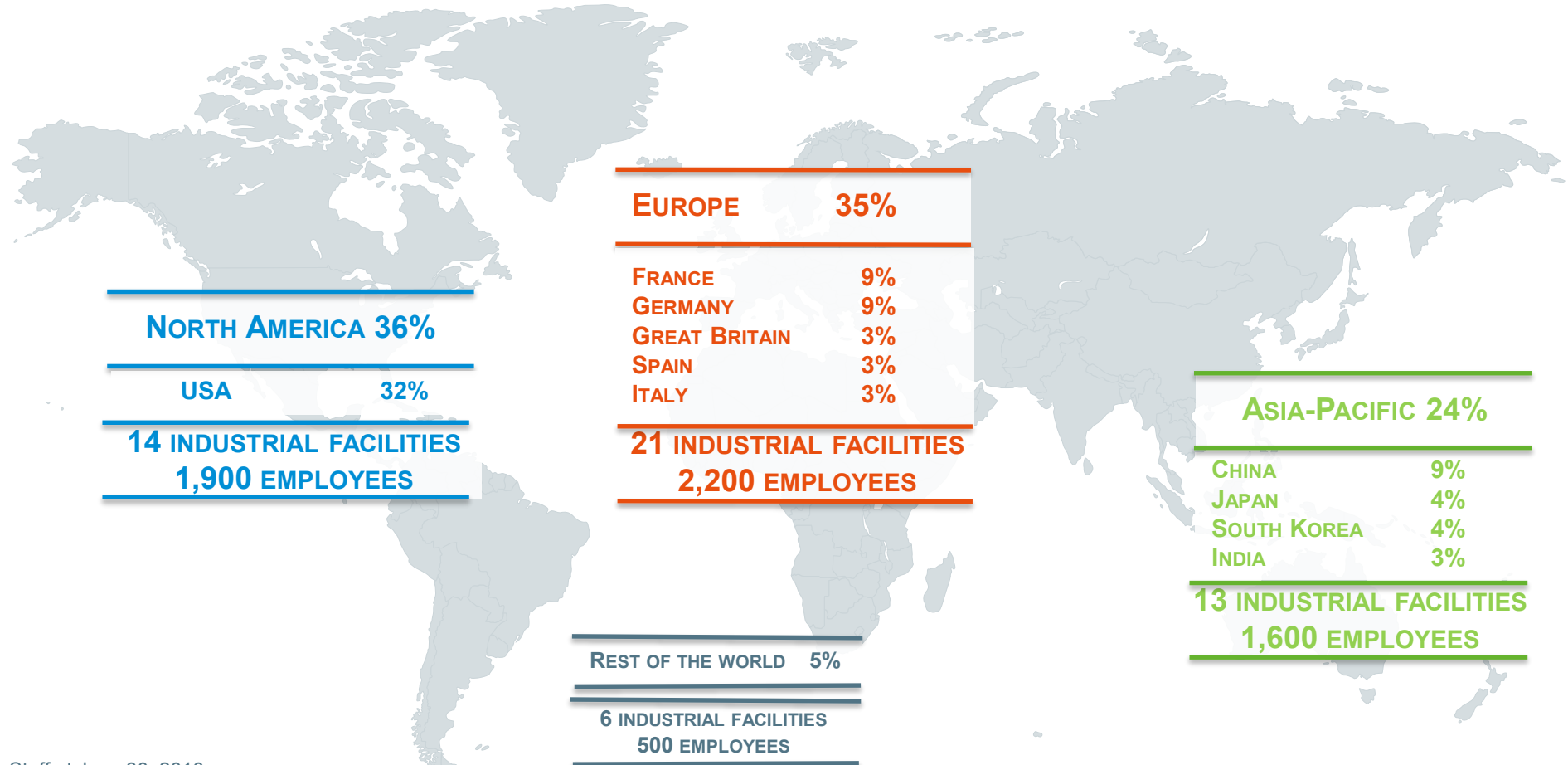
- **CYCLICAL BUSINESS (CHEMICAL, GRAPHITE)**
- **HIGH EBITDA: 17% (5Y. AVERAGE)**
- **CAPITAL INTENSIVE (DEPRECIATION: 7.4% OF SALES)**
- **STRONG OPERATIONAL LEVERAGE: OVERCAPACITY IN GRAPHITE + LOW LEVEL IN CHEMICAL**

### *ELECTRICAL POWER*

- **LESS CYCLICAL BUSINESS**
- **EBITDA: 14% (5Y AVERAGE)**
- **LOW CAPITAL INTENSIVE (DEPRECIATION : 2.4% OF SALES)**

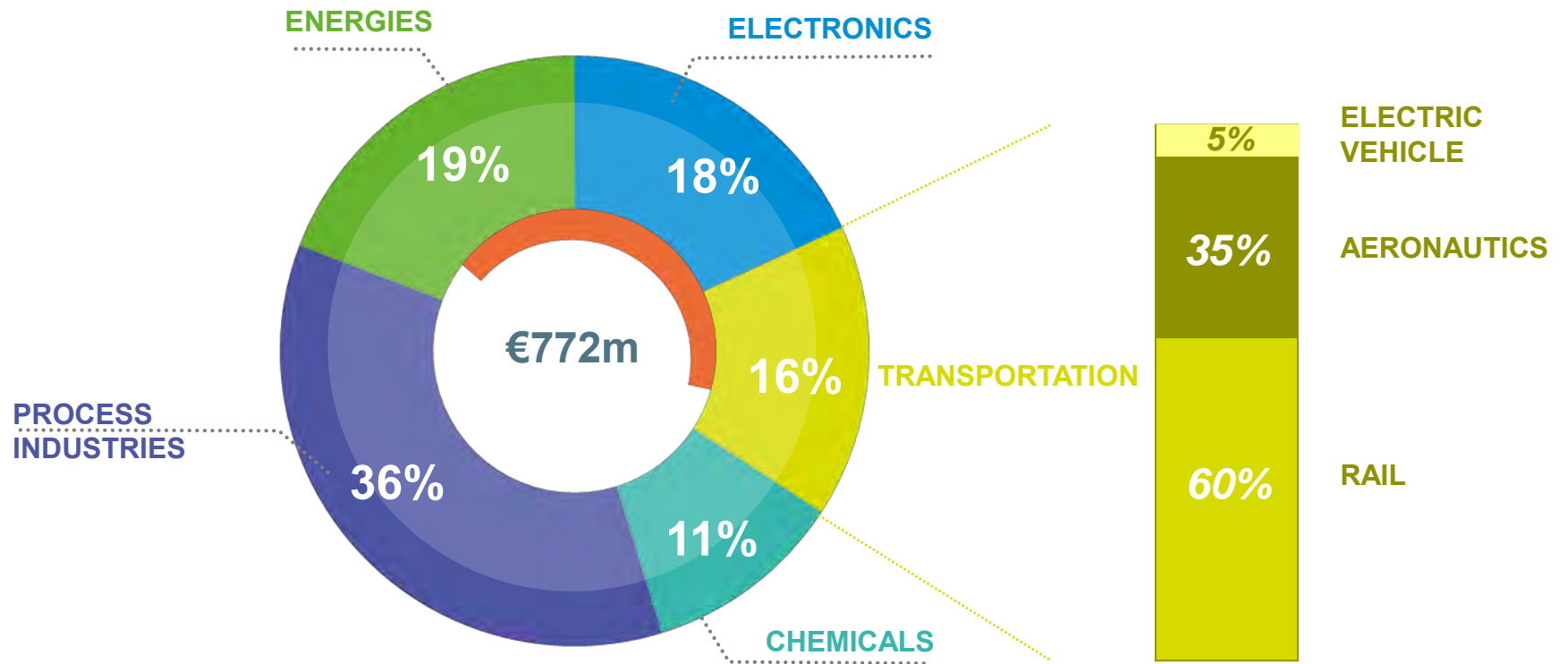


# A GLOBAL NETWORK PROVIDING OPPORTUNITIES AND ROBUSTNESS



Staff at June 30, 2016  
% based on 1st half 2016 Sales

# EXPANDING MARKETS...



2015 Sales figures

# PILLARS OF OUR STRATEGY

- Maintain « best in class » **safety standards**
- Implement **Operational Excellence plan**
- **Cash initiative**



- Increase **synergies** in the segments
- Lean on the **3 new corporate positions** to deploy strategy
- Develop **talents** targeted toward some **key functions**
- Emphasize **collaboration** within the Group

- **Expanding** markets (solar, wind, electronics)
- Effective **innovations**
- Selective **acquisitions**
- **Tap potential** on new markets (EV, ...)

# AN AMBITIOUS STRATEGY TO MAKE THE GROUP MORE ROBUST AND COMPETITIVE



# AN ACTIVE PORTFOLIO MANAGEMENT

## PURSUE PLANS FOR SELECTIVE ACQUISITIONS



- Consolidate our **core businesses** to strengthen our leadership
- Expand in **geographical regions** recording strong growth
- Acquire **growth platforms** in adjacent business segments
- Acquire **key expertises**

JV Harbin

## DIVESTITURE OF PRODUCT LINES HAVING NO SYNERGIES WITH THE REST OF THE GROUP



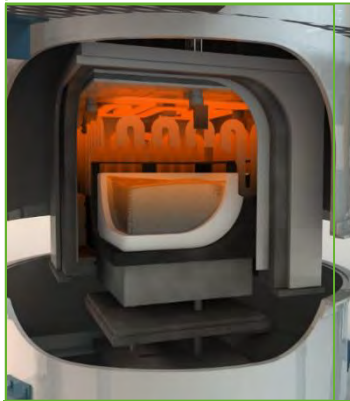
- Proposed divestment of high-voltage switches business (St Loup de Naud plant in France – Sales of €5m)

# INNOVATION: CENTRAL TO OUR GROWTH MODEL

## NEW POSITION IN THE EXECUTIVE COMMITTEE

- 1 IMPROVE INNOVATION MONITORING
- 2 ANTICIPATE CUSTOMER ISSUES
- 3 BRING PRODUCTS TO THE MARKET QUICKLY

## MATERIALS FORMULATION



- Solar
- Electronics

## CONTINUOUS FLOW REACTOR IN SIC



- Specialty chemicals

## LASER OPTICS



- Laser

## HYBRID TECHNOLOGY

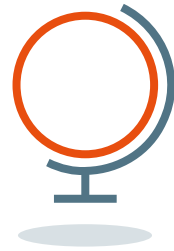


- Energy storage

Disruptive innovations

# OVER THE MEDIUM TERM, AN AMBITION OF GROWTH BOTH IN SALES AND PROFITABILITY

## MERSEN'S STRENGTHS



**MARKETS AND GEOGRAPHIES  
DIVERSIFICATION**



**VIBRANT  
EXPANDING MARKETS**



**AMBITIOUS  
COMPETITIVE PLAN**



**ABILITY TO  
ADAPT QUICKLY**

# TRANSPORTATION MARKET, A SIGNIFICANT GROWTH POTENTIAL IN THE MEDIUM-TERM

**MODIFIER**

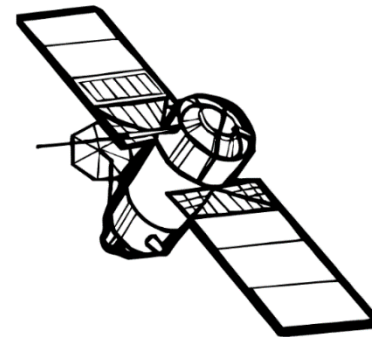
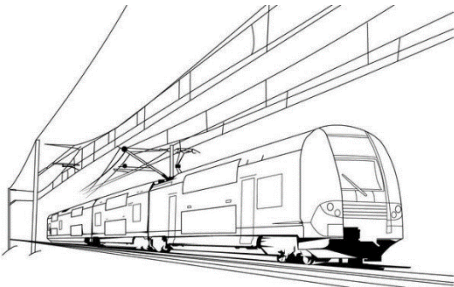
**CAGR**  
**[5-12%]**

**2020**

**€[160-220]M**

**2015**

**€125 M**





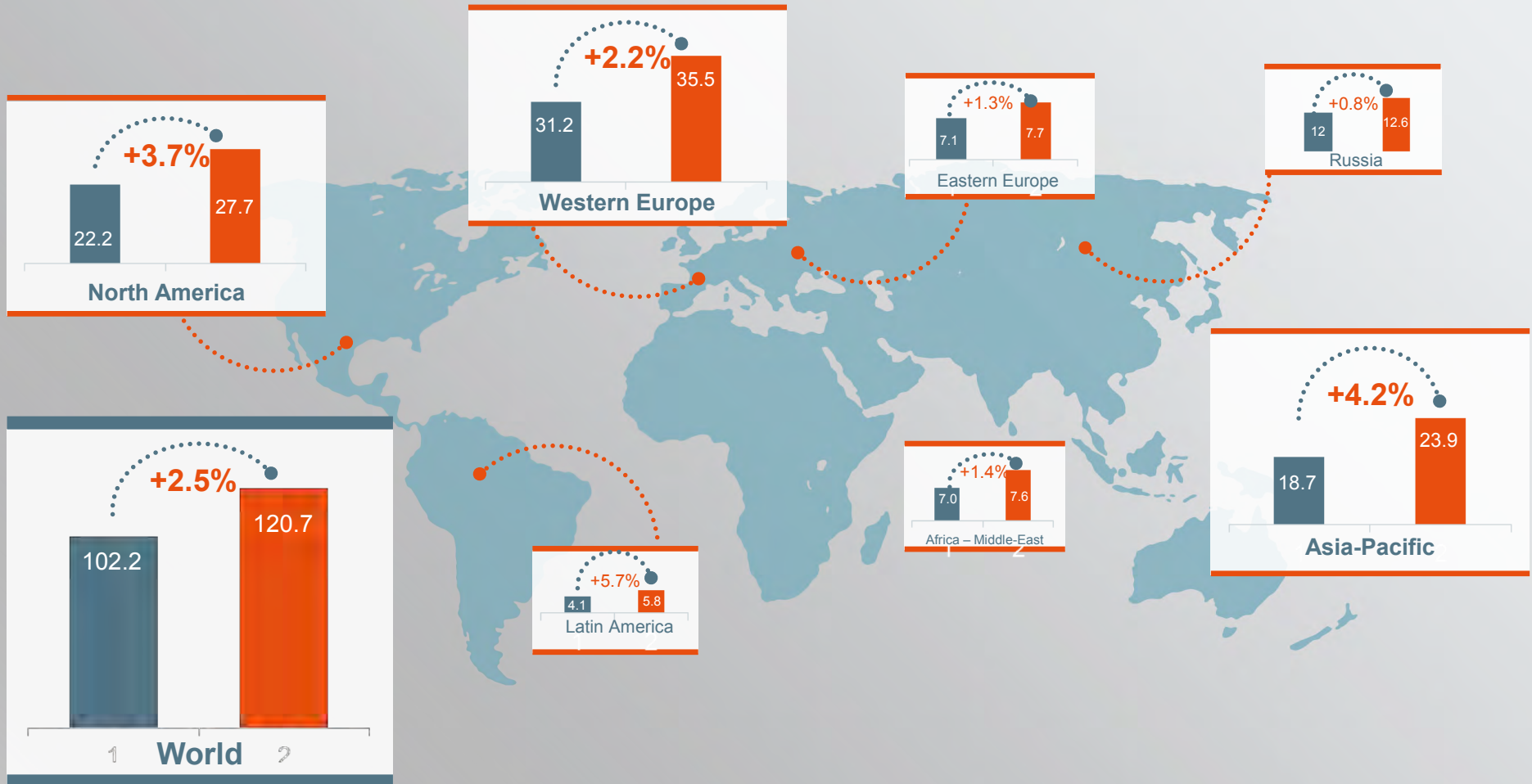


# MERSEN IN THE RAIL MARKET

GILLES BOISSEAU, SVP ELECTRICAL POWER



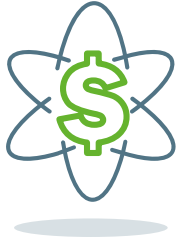
# RAIL MARKET: A GROWING TREND IN OUR MAIN GEOGRAPHIES



■ Market volume 2011-13 per year  
■ Market volume 2017-19 per year

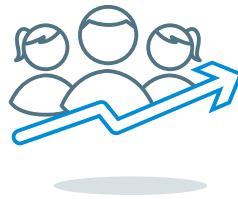
Sources: UNIFE – Accessible market volume in €bn (Rolling stock, infrastructures, Signaling systems, Services)

# WHAT DRIVES THE RAIL MARKET?



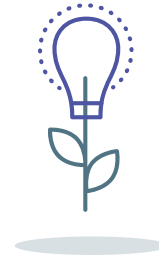
## MACRO-ECONOMY

- States' stimulus packages
- Market liberalization
- Network interoperability



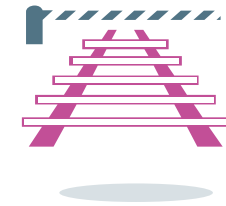
## DEMOGRAPHY

- Growth of urban populations, mainly in emerging nations
- Increasing mobility & infrastructure saturation



## ENERGY & ENVIRONMENT

- Car losing ground in Europe
- Rail's green tag for freight transport
- Energy efficiency



## INFRASTRUCTURE

- Refurbishing
- Electrification
- Predictive maintenance

# GROWTH DRIVERS BY GEOGRAPHY





# MERSEN IS POSITIONED ON ALL SEGMENTS OF THE ROLLING STOCK MARKET



LOCOS

→ + 0.9% CAGR



HIGH & VERY HIGH SPEED

↗ + 2.4% CAGR



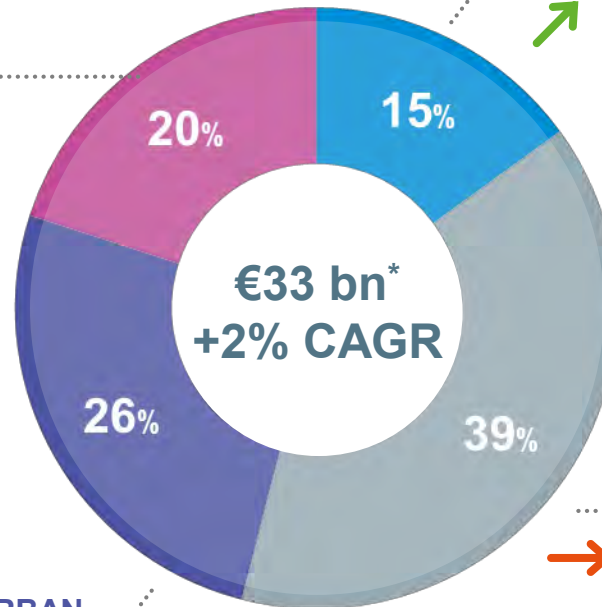
URBAN

↗ + 4.0% CAGR



INTERURBAN

→ + 0.8% CAGR



UNIFE 2017-19  
RoS Accessible Market Outlook

\*2011-2013 Rail market breakdown (Rolling stock)

# MERSEN'S PRODUCT OFFER...

## VIA POWER INVERTERS



Cooling devices



Bus Bars

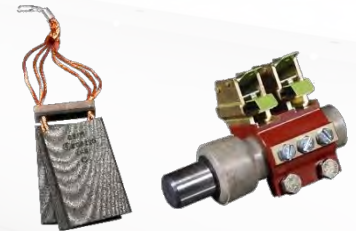


Fuses & fuse boxes

## ENERGY SUPPLY



## To MOTORS



Brushes and brush-holders



Pantograph strips  
or  
3<sup>rd</sup> rail collector



Motor Maintenance Service

AVERAGE MERSEN'S SALES  
IN EACH METRO TRAIN  
[€80-100 κ]

# ... FOR A GLOBAL CUSTOMER BASE: CAR BUILDERS AND...



Non exhaustive list

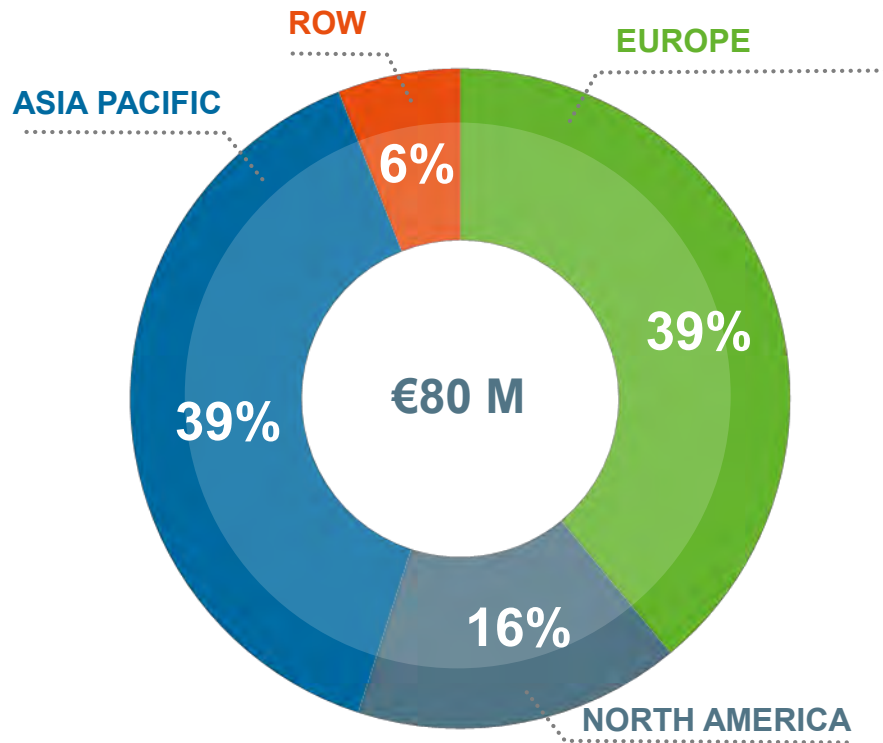
# ... OPERATORS FOR THE AFTER MARKET



Non exhaustive list



# RESULTING IN SALES ALL AROUND THE GLOBE



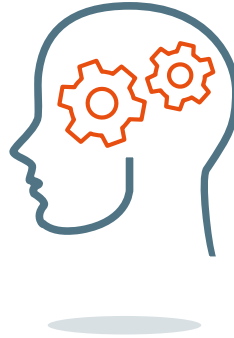
## MERSEN'S 2015 SALES BREAKDOWN IN RAIL

# MERSEN'S KEY SUCCESS FACTORS



## POWERFULL MANUFACTURING BASE

- **Able to provide local content**
- High technical skills
- Testing capabilities



## BROAD EXPERTISE

- Meet transportation norms & certifications  
Normalization capability
- Complete solution: study, offer, after-sales, services...
- Large installed base with strong customer relationships



## STRONG ORGANIZATION

- Global organization
- Dedicated local vendor at OEM
- Aftermarket special sales team



- **INCREASE PARTNERSHIPS WITH OEM  
FROM PRODUCT INNOVATION TO CO-DEVELOPMENT**
  
- **DEVELOP « GREEN » OFFER**
  - Wireless technologies
  - Predictive maintenance
  - “Redesign to cost” offer
  
- **FOCUS ON DEVELOPING GEOGRAPHIES (INDIA,  
CHINA, ...)**

# ILLUSTRATION OF THE STRATEGY: HARBIN JV



## ■ THE CHINESE RAIL MARKET

- 39,000 active locomotives (compared to 29,000 in the USA) with a high utilization rate (80 to 90%)
- Largest high speed train network (five times bigger than SNCF)

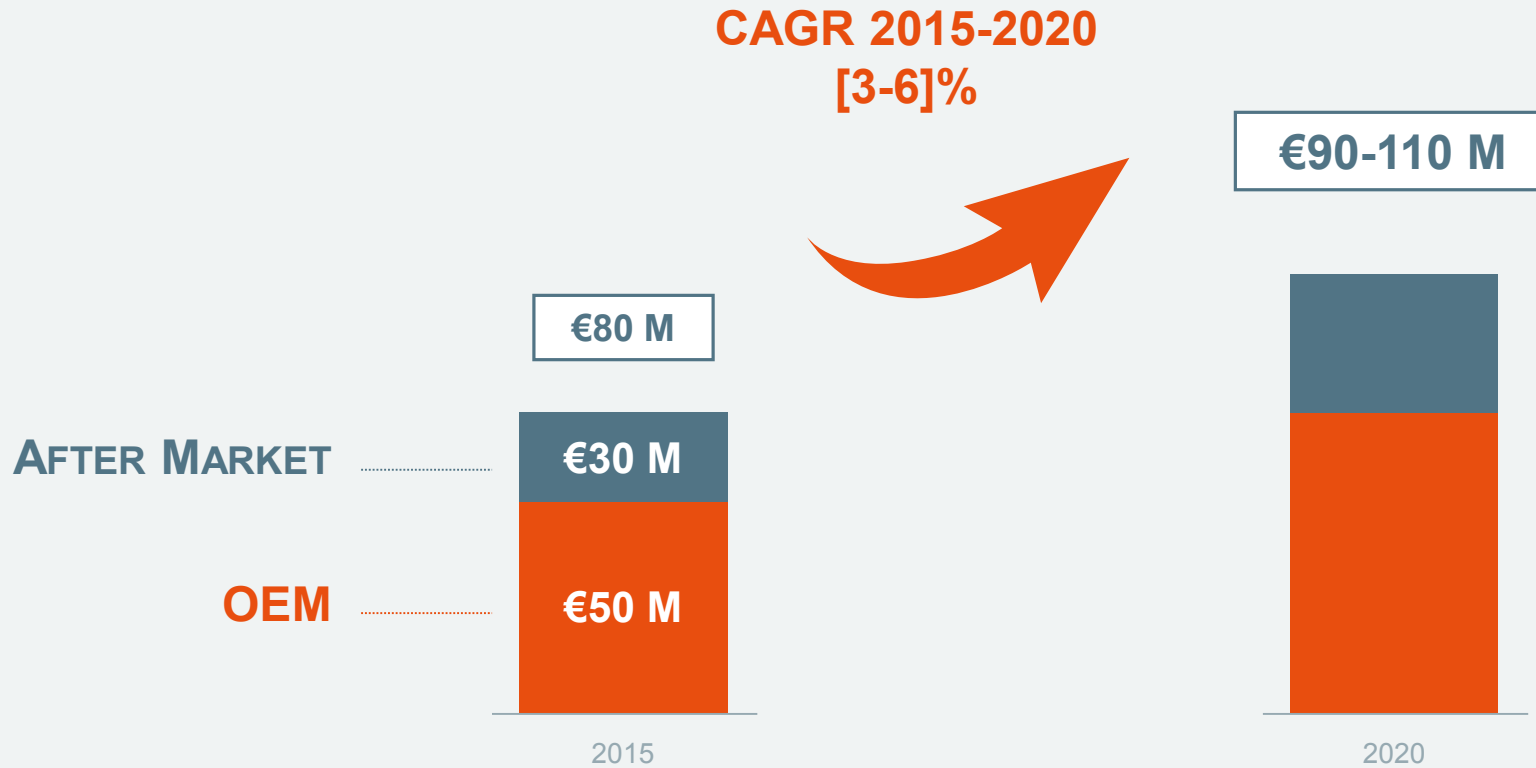
## ■ OBJECTIVES FOR MERSEN

- Expand product range sold to Chinese railways to pantograph strips and traction brushes
- Leverage Harbin CRCC certifications and direct contacts with decision makers

## ■ JV POTENTIAL

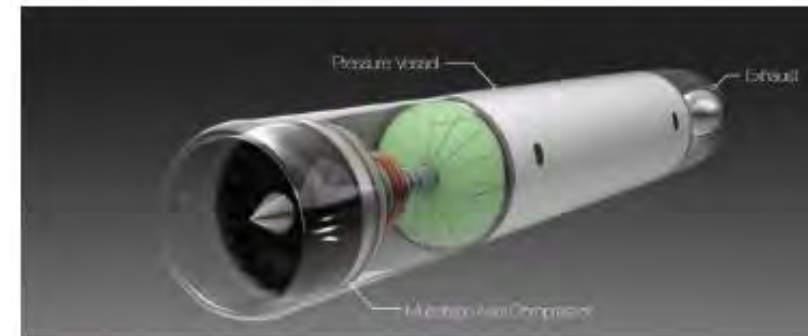
- ~ €10 million in 5 years

# MERSEN POTENTIAL IN RAIL



# WHAT'S NEXT? HYPERLOOP?

- **HYPERLOOP: SUPER-HIGH GROUND TRANSPORTATION CONCEPT PROPOSED BY ELON MUSK (OBJECTIVE: LOS ANGELES – SAN FRANCISCO IN 35 MINUTES)**
- **MERSEN PARTNERING WITH TRANSPOD (CANADA) ON COOLING SOLUTIONS**
- **FULL-SCALE CONCEPT PRESENTED AT INNOTRANS BERLIN (SEPT. 2016)**







# MERSEN IN AEROSPACE

ERIC GUAJIOTY, SVP ADVANCED MATERIALS

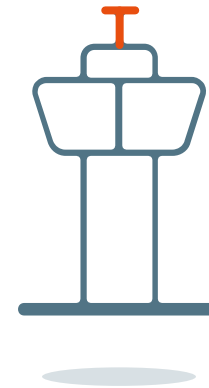


# AEROSPACE: AN ATTRACTIVE MARKET FOR MERSEN



**CIVIL AIRCRAFT MARKET  
OUTPERFORMS WORLD  
GDP GROWTH**

New aircrafts ► new equipment  
for Mersen



**WORLD AIR TRAFFIC HAS  
ALWAYS\* OUTPERFORMED  
GDP AND WILL CONTINUE**

A strong potential in terms  
of aftermarket

\*Source: Airbus

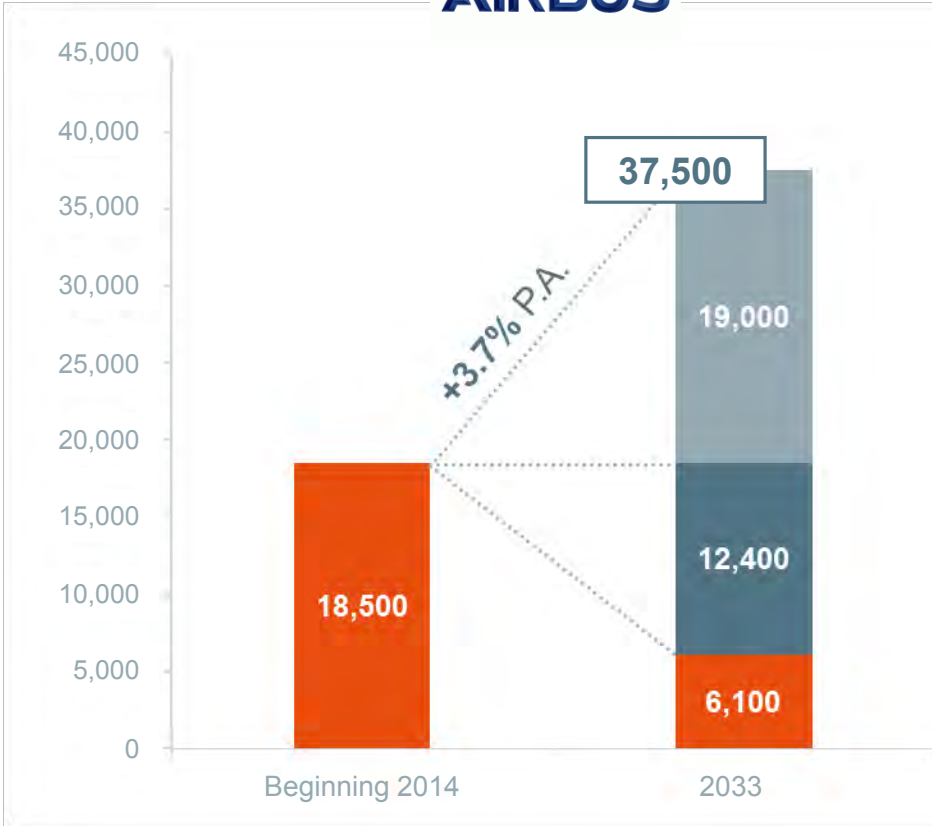


# CIVIL AIRCRAFT MARKET OUTPERFORMS WORLD GDP GROWTH : A STRONG POTENTIAL FOR OEM SALES

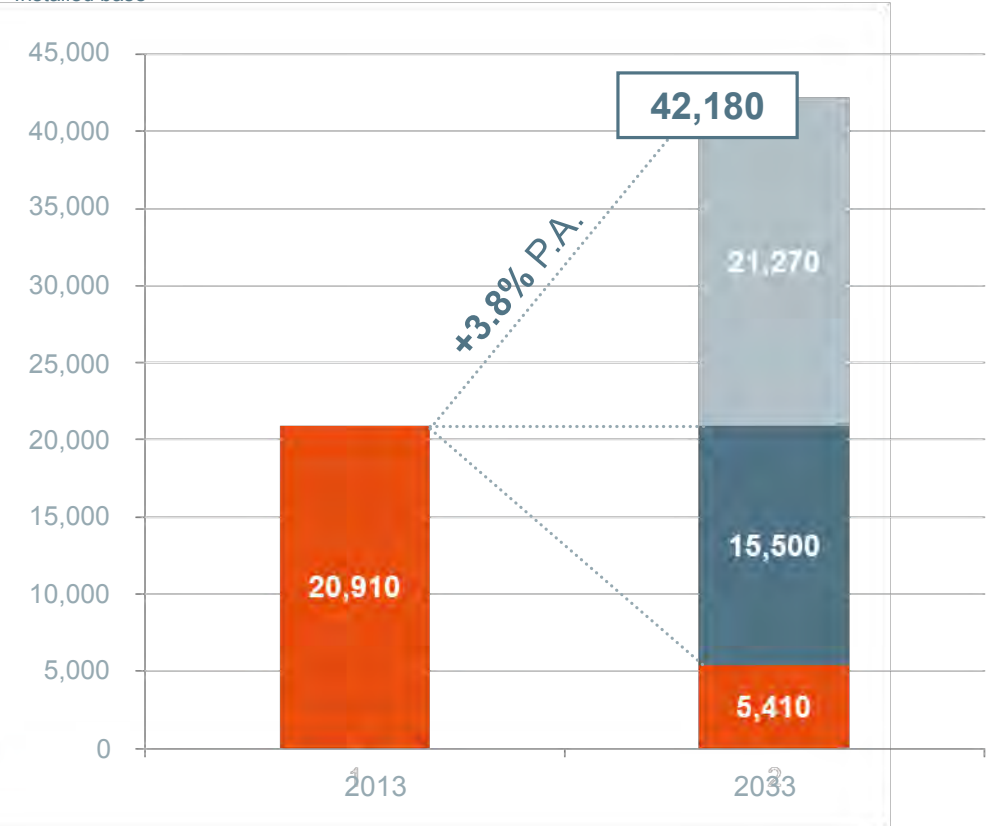


**AIRBUS**

Nb aircraft  
Installed base



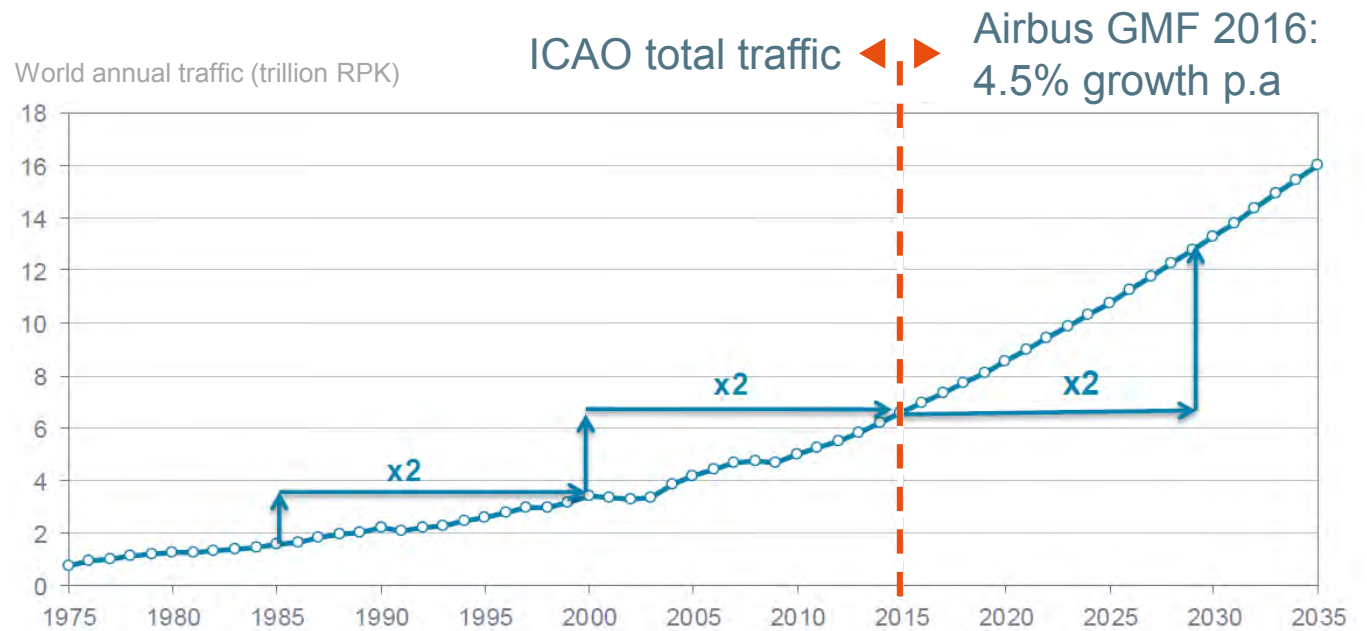
Nb aircraft  
Installed base



■ Current   
 ■ Replacement   
 ■ Growth

Sources: Airbus Global Market Forecast 2014; Boeing Current Market Outlook 2014

# INCREASING AIRCRAFT UTILIZATION RATE: A STRONG POTENTIAL FOR AFTERMARKET



Sources: ICAO (International Civil Aviation Organization), Airbus GMF 2016  
RPK: Revenue Passenger Kilometres

# WHAT DRIVES THE MARKET?



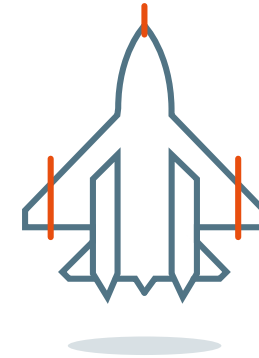
## DEMOGRAPHY

- Increasing middle-class in emerging countries
- Tourism
- Business
- Lack of other infrastructure (USA, India, ...)



## GLOBAL COST

- Increase efficiency
- Extend maintenance cycles
- Reduce maintenance costs: more electric devices, less hydraulic; replace old aircrafts



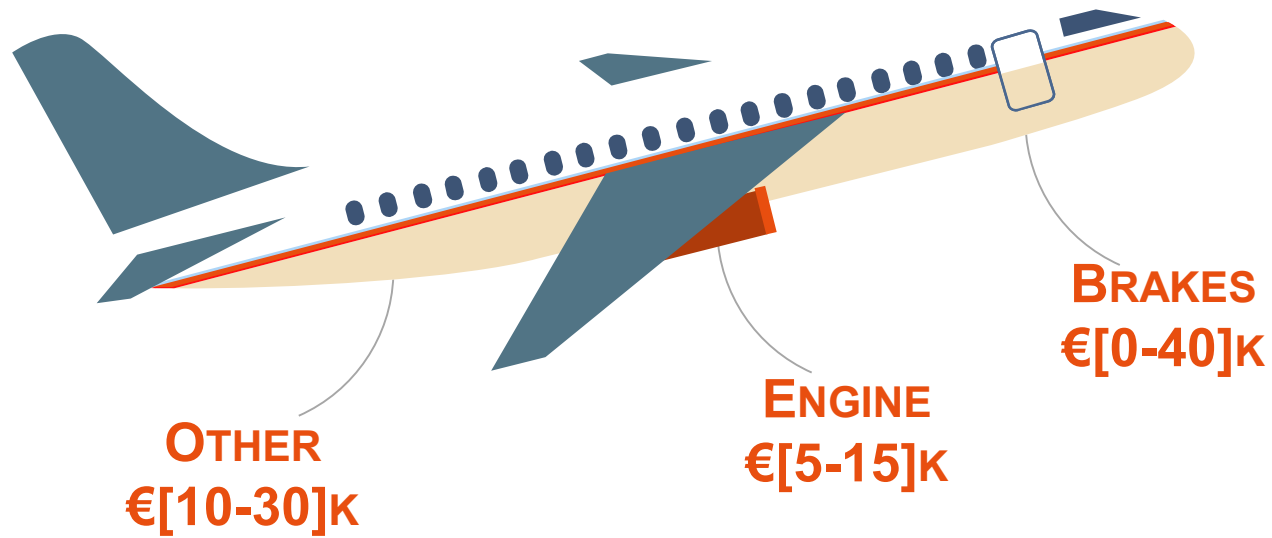
## DEFENCE

- National sovereignty

# MERSEN' SOLUTION FOR AERONAUTICS



# MERSEN IN AN AIRCRAFT\*



**TYPICAL MERSEN'S SALES  
IN AN AIRCRAFT:  
[€15-60] K/AIRCRAFT**

\*latest generation

# STRONG NETWORK: MERSEN IS SERVING ALL THE PLAYERS IN THE FIELD



# MERSEN'S KEY SUCCESS FACTORS



## INSTALLED BASE

- **Long term relationship** with major manufacturers worldwide



## HIGH TECHNICAL BARRIERS TO ENTRY

- Plant certification for aeronautics – EN9100
- Equipment/process qualification for aeronautics
- Product approval for customers



## BROAD EXPERTISE

- Able to comply with new technical challenges:
  - Materials knowledge
  - Increase product lifetime
  - Develop lighter and more compact product
  - Increasing engine temperature



## POWERFUL MANUFACTURING BASE

- High technical skills on a regional basis
- Able to follow a strong ramp-up

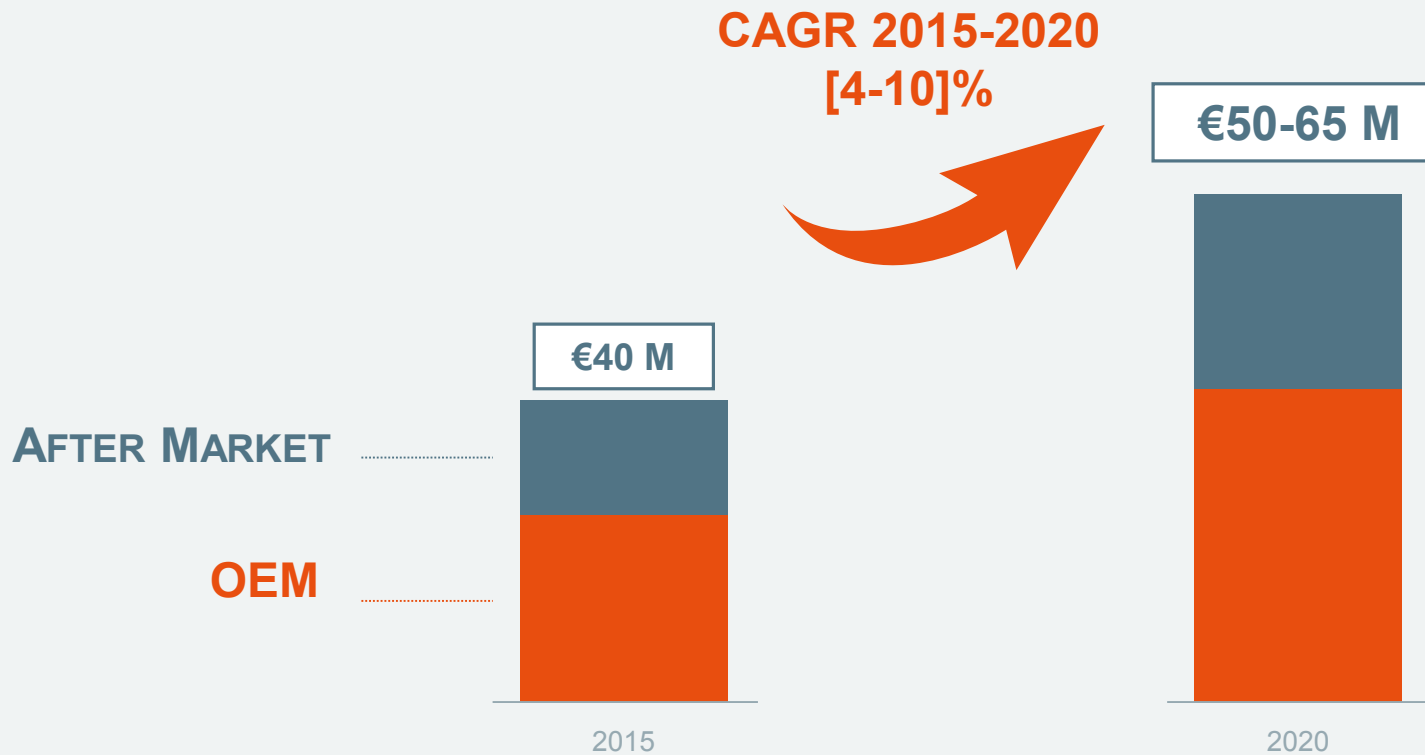
# STRATEGY



- **SUPPORT TECHNOLOGICAL CHALLENGES:  
“MORE THRUST, LESS WEAR, LIGHTER”**
- **LEVERAGE TECHNOLOGICAL DEVELOPMENT  
IN AERONAUTICS FOR OTHER MERSEN’S MARKETS**
- **DEVELOP OUR CUSTOMER PORTFOLIO WITH THE  
“ALL ELECTRIC” AIRCRAFTS (POWER ELECTRONICS)**
- **STRENGTHEN OUR CUSTOMER’S RELATIONSHIP AND  
QUALIFY FOR THE AIRCRAFT’S NEW GENERATIONS**



# MERSEN POTENTIAL IN AERONAUTICS



# WHAT NEXT?





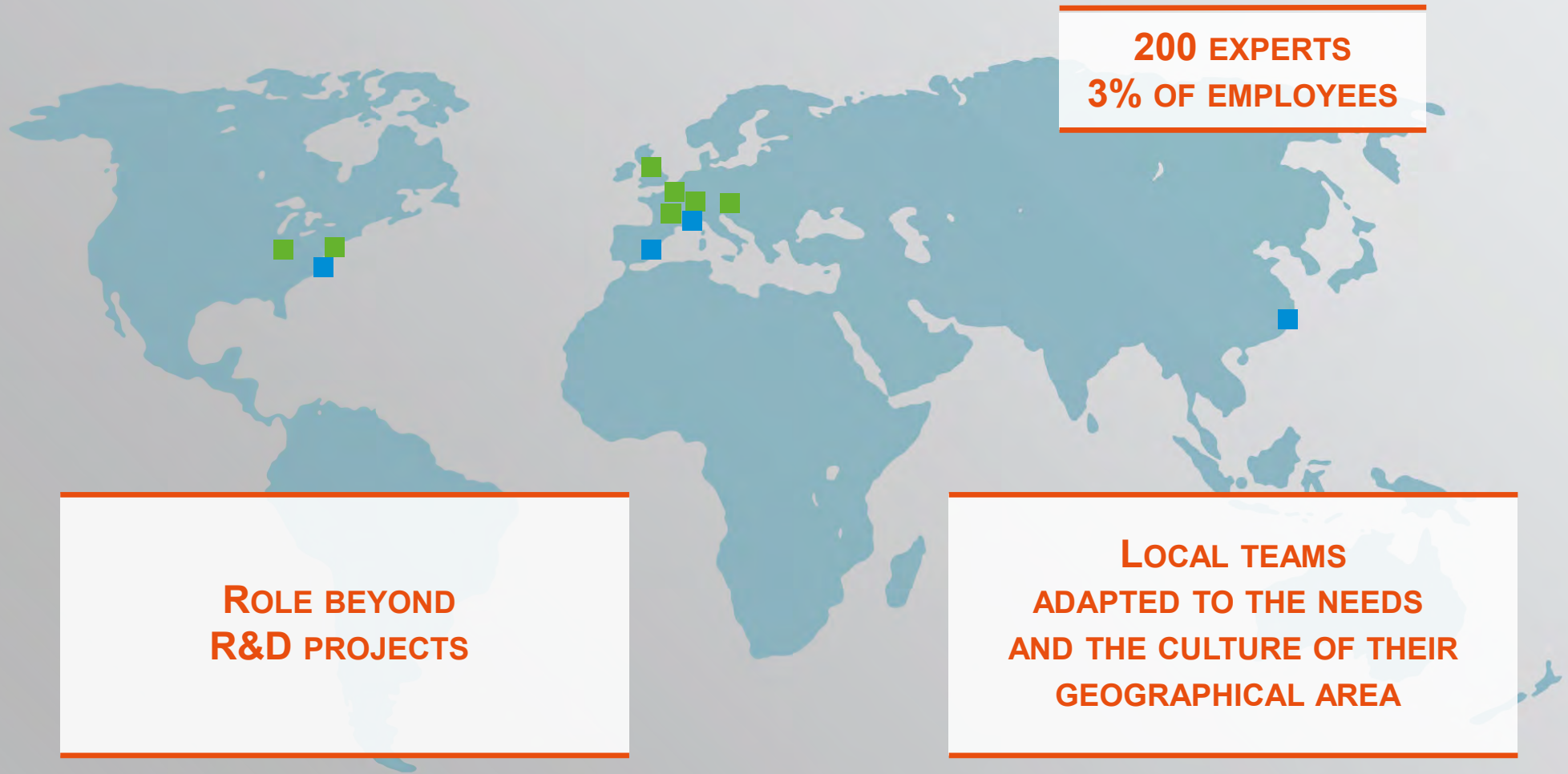
# INNOVATE AT MERSEN

CHRISTOPHE BOMMIER

SVP, TECHNOLOGY, RESEARCH, INNOVATION &  
BUSINESS SUPPORT



# CENTERS OF EXPERTISE CLOSE TO THE CUSTOMERS

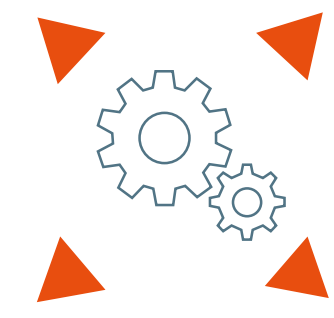


# A CORPORATE POSITION TO IMPROVE EFFICIENCY



**ANTICIPATE MARKET DEMANDS**

**BUILD BRIDGES BETWEEN THE DIFFERENT BUSINESS UNITS**



**CREATE DIFFERENTIATION VIA CUTTING-EDGE TECHNOLOGIES**

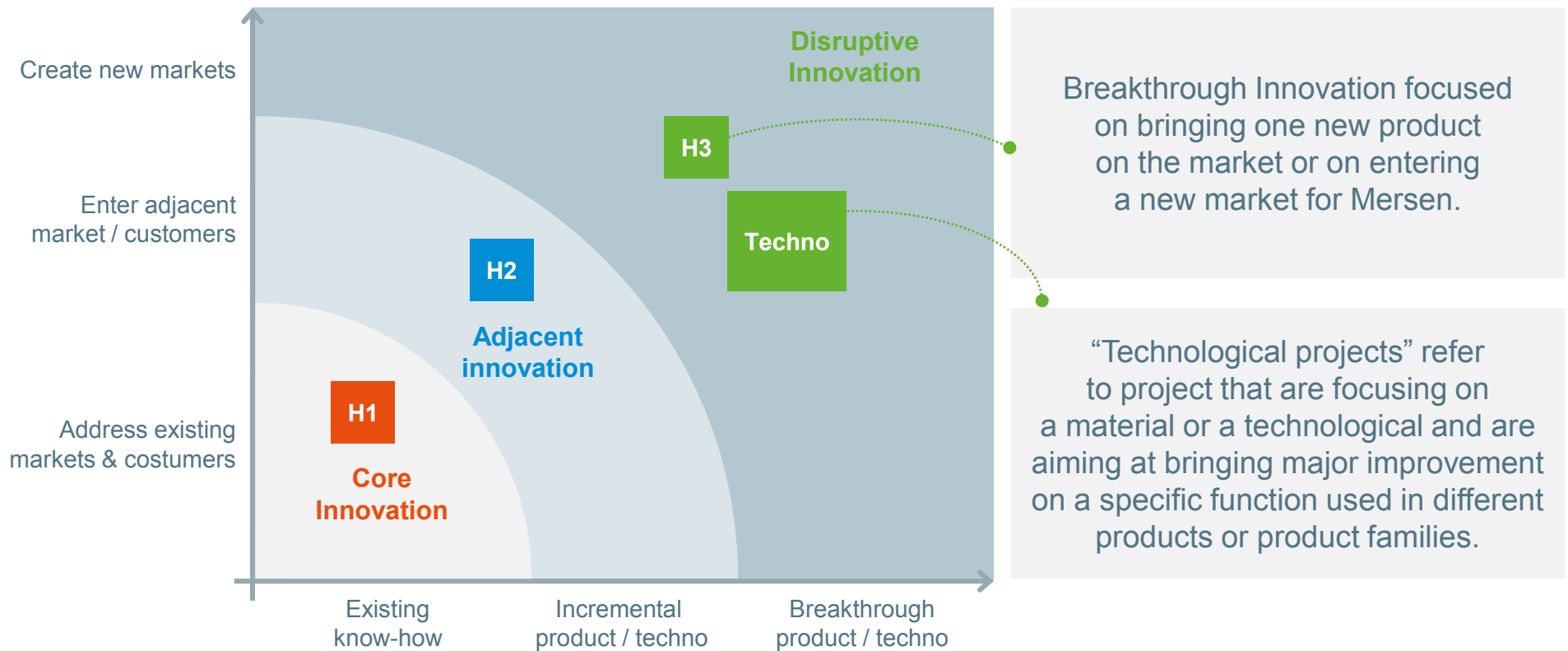
**OPTIMIZE RESOURCES ALLOCATION**



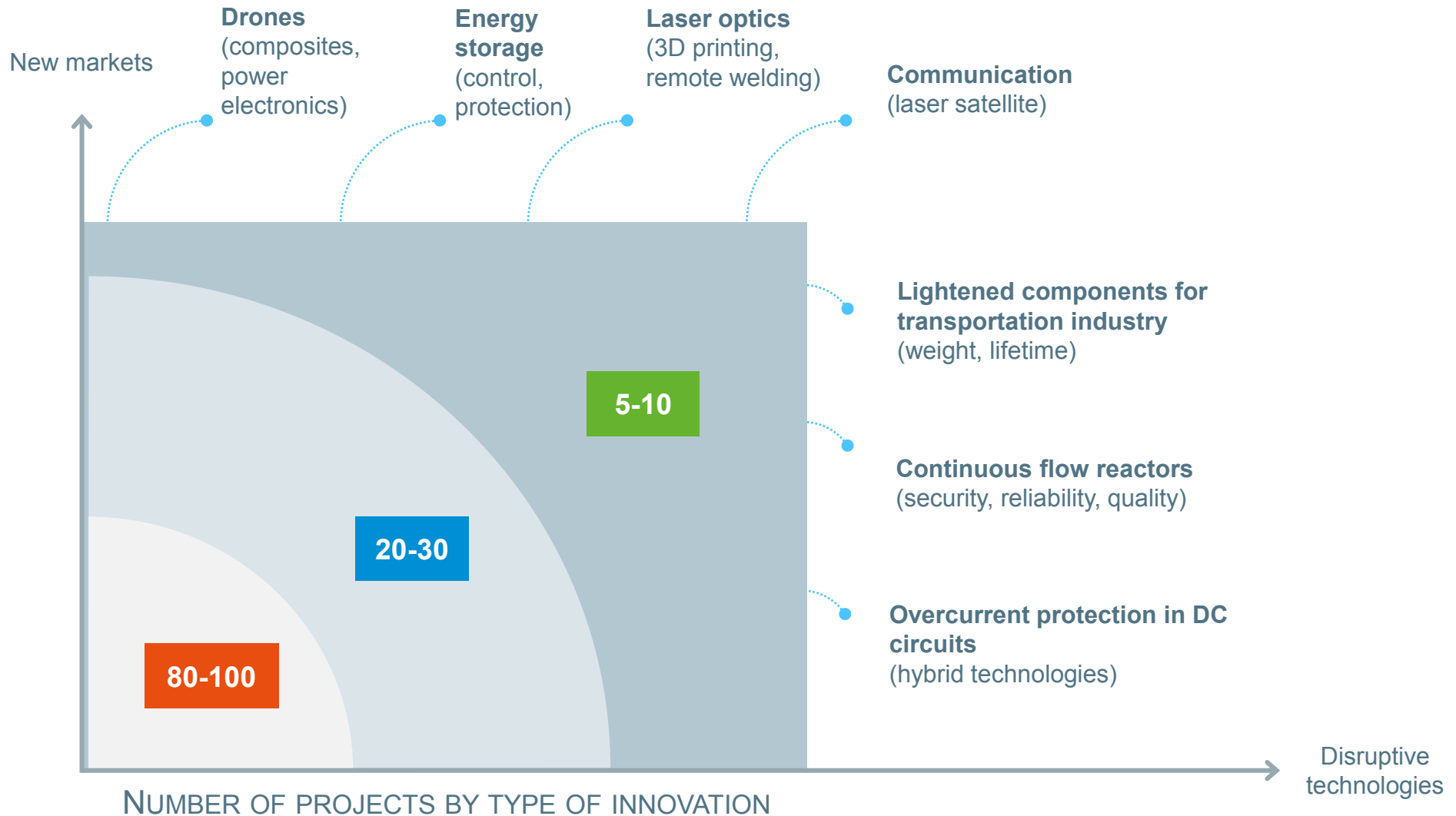
**OBJECTIVE: BRING QUICKER THE NEW PRODUCTS TO MARKET**

# SHARED METHODS

## TYPES OF INNOVATION PROJECTS



# A PROJECT PORTFOLIO BALANCED BETWEEN MEDIUM- AND LONG TERM



# DIFFERENTIATION SUCCESS STORIES: POTENTIAL SALES UP TO € 100 M BY 2020

## EXAMPLES

### CONTINUOUS FLOW REACTORS

INTRODUCED IN 2011



### LARGE SIZE CARRIER FOR ALD REACTOR

FIRST PRODUCTS SOLD IN 2015





# 2020 POTENTIAL REVENUE ACHIEVED THROUGH INNOVATION

**6%**

OF ANNUAL REVENUE ACHIEVED THROUGH CORE INNOVATION  
GENERATING LITTLE ADDITIONAL SALES

**2020 HORIZON**

**3-5%\***

OF REVENUE ACHIEVED THROUGH  
ADJACENT INNOVATION WHICH WILL  
GENERATE NEW SALES

**3-8%\***

TARGET POTENTIAL REVENUE  
ACHIEVED THROUGH  
DISRUPTIVE INNOVATION

\* Based on 2016 sales figure

# INNOVATIONS FOR THE TRANSPORTATION MARKET

## PASSIVE COMPONENTS



■ METRO TRAIN

## STATIC CURRENT COLLECTOR



■ WIRELESS TRAM

## HYBRID SWITCH



■ ELECTRIC VEHICLES



Disruptive Innovations



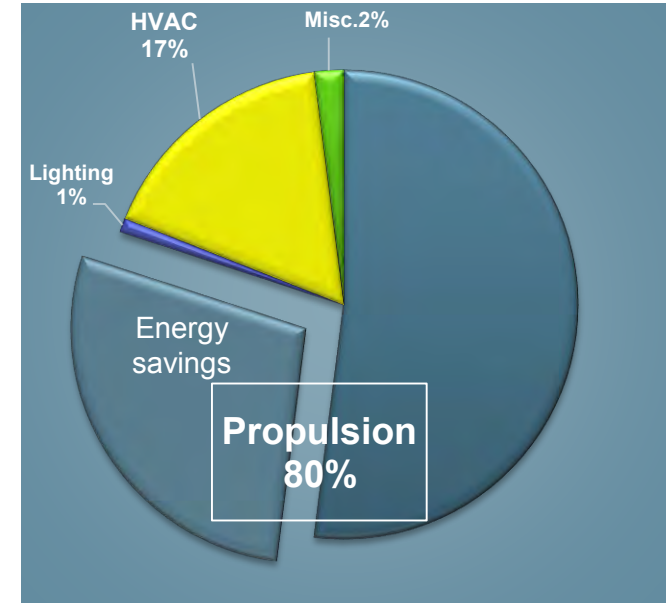
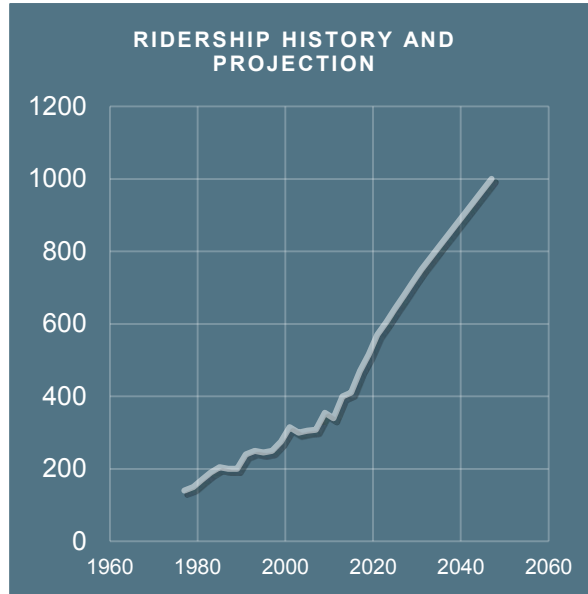
# SAN FRANCISCO BAY AREA RAPID TRANSIT

MERSEN AT THE CORE OF A FLEET RENEWAL PROGRAM

CHRISTOPHE BOMMIER



# BART SITUATION

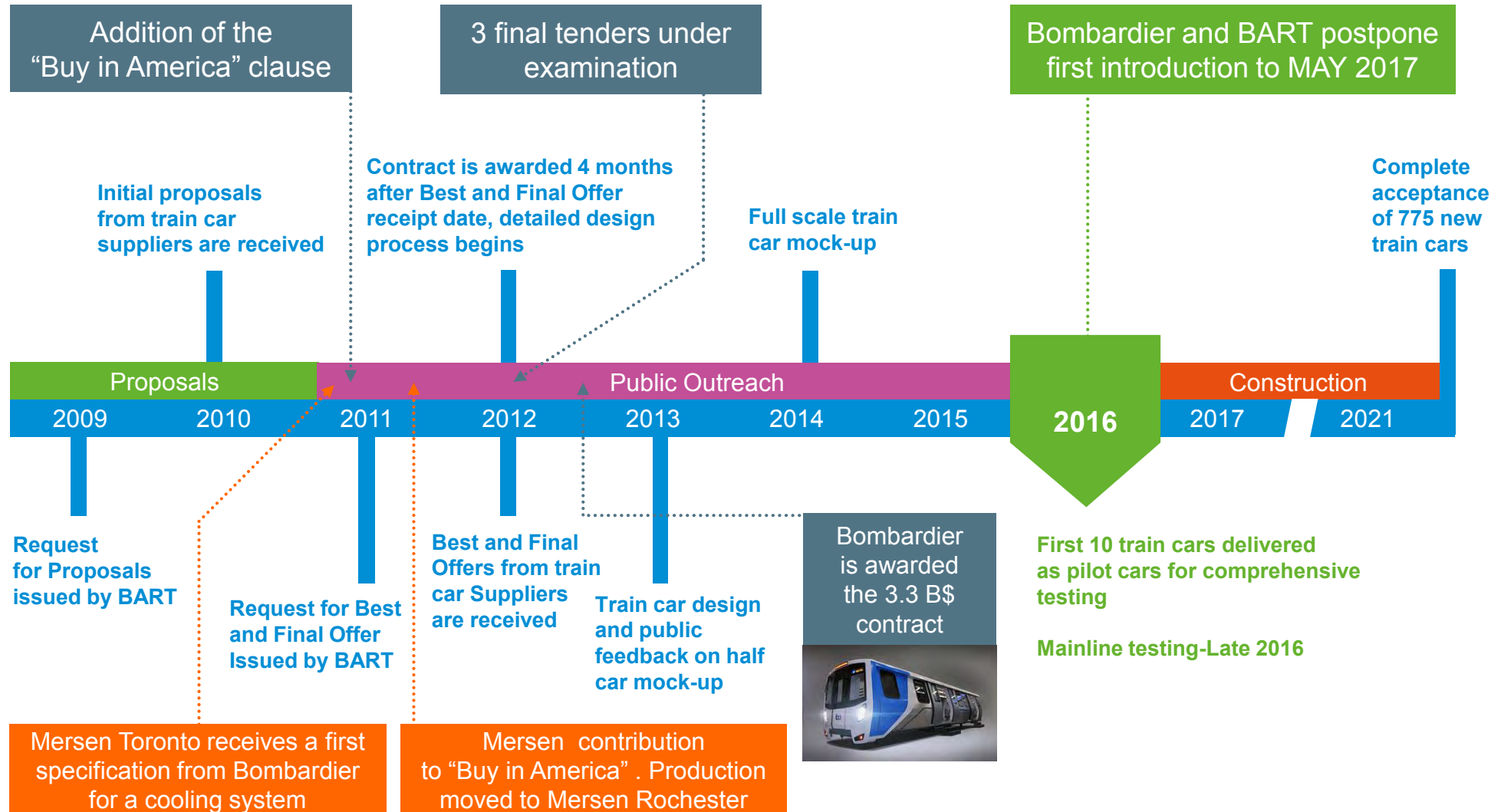


**40-YEARS OLD, EXTENDED, RENOVATED .. ON THE VERGE OF OBSOLESCENCE**

**NEEDS TO ADD CAPACITY TO THE CURRENT BART SYSTEM TO SERVE MORE RIDERS.**

**HIGH POTENTIAL ENERGY SAVINGS WITH NEW BRAKING SYSTEMS THUS NEW COOLING DEVICES**

# 2009–2021: BART“ NEW TRAIN CAR PROJECT ”



# BOMBARDIER DEMAND TO MERSEN: A COOLING SYSTEM FOR THE POWER MODULES

## ■ OBJECTIVE

- Cooling of an Inverter with Dynamic Brake
- + **25% thermal performance over last Mersen's design (NY Transit)**

## ■ REQUIREMENT

- **Compliance to “Buy in America” Act**

## ■ MERSEN'S SOLUTION:

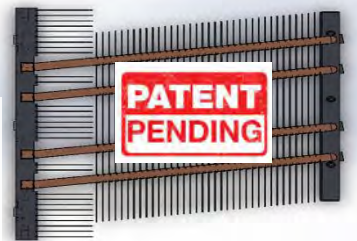
- Mersen Cold Wall Assembly
- Relying on Mersen Rochester for the production phase of the project



# THE MERSEN NETWORK IN ACTION

## 2- TORONTO (CANADA) HYBRID DESIGN

TESTED IN 2013  
MEET THE REQUIREMENTS,  
BUT NOT SAFETY MARGIN



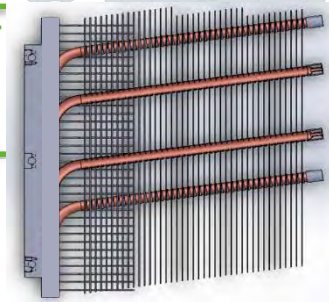
## 1- EARLY PROPOSAL LA MURE (FRANCE)

TESTED BY BOMBARDIER  
IN ZURICH (SWITZERLAND)  
IN 2012  
LOW COST BUT UNDER SPEC



## 3- COLLABORATIVE EFFORT BETWEEN TORONTO AND LA MURE

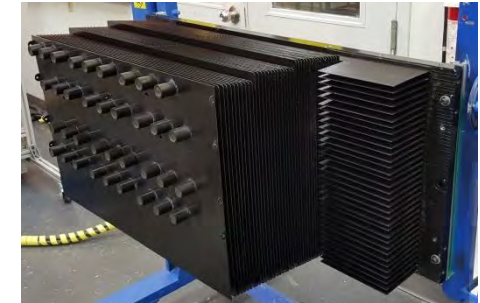
TESTED IN 2015  
EXCEEDS PERFORMANCE  
BY 20% ON AVERAGE



APPROVED

# THE “REST” FOLLOWED

- **A MULTI-YEAR CONTRACT TO SUPPLY COOLING DEVICES AND LAMINATED BUSBARS: 765 SYSTEMS TO BE DELIVERED BETWEEN 2016 AND 2021 FOR \$8.5 MILLION**
- **PRIMARY SUPPLIER CONTRACT AWARDED TO MERSEN IN JULY 2016**
- **FIRST “BUY IN AMERICA” RELEASE IN SEPTEMBER 2016**



Toronto – June 2016



Rochester – September 2016



# WHAT NEXT?

- **BART: POSSIBLE SECOND PHASE FOR + 250 CARS**

- **RAIL URBAN PROJECTS: +4% CAGR\***

- Existing pipe-line of “metro” projects, most of them requiring a custom made solution

\* UNIFE 2017-19 *Accessible Market Outlook*





# WIRELESS TRAM

MERSEN'S CONTRIBUTION TO A NEW CONCEPT

CHRISTOPHE BOMMIER





# 3 POWER SUPPLY TECHNOLOGIES FOR TRAMWAYS



## ■ CATENARY

- Current collection by pantograph strips.



## ■ GROUND-LEVEL POWER SUPPLY (APS)

- Power supplied by third rail at the ground level.



## ■ WIRELESS TECHNOLOGY (SRS)

- Fast charging of supercapacitors at each tram stop.

# WHY A WIRELESS ENERGY TRANSMISSION, & HOW TO MAKE IT MORE COMPETITIVE?

## The WHYS



**Lyon** 1956. Catenary (Esthetic?  
How to raise a firefighter ladder?)



**Amsterdam** suburb 2015.  
Aerial 3<sup>rd</sup> rail (Closed space)

## The COSTS



**Bordeaux** 2003. APS\*  
(buried segmented third rail)



**Nice** 2017-2018: SRS\*\*

\* Ground-level power supply | \*\* Static Charging System.

# SRS, THE PRINCIPLE





# WIRELESS TRAM

1 | Arrival to station

2 | RF Signal from ground confirms proper positioning

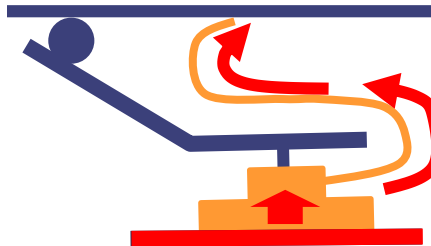
3 | Static current collectors are lowered

4 | High intensity currents are collected and sent to supercapacitors to complement the charge

5 | The source is deactivated. Static current collectors are raised. Departure is imminent

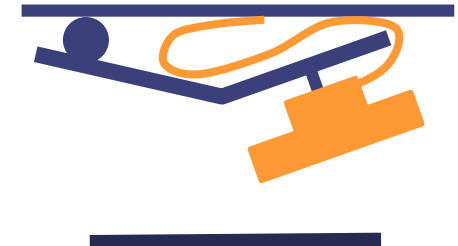


Inactivated source



Activated source

750 volts, 2 x 800 AMPS, 20 seconds  
(6 kW.hr, equivalent to 0.7 l of diesel)



Inactivated source

# MERSEN'S CONTRIBUTION TO SRS TECHNOLOGY:

## THE CURRENT COLLECTOR SYSTEM



The articulated current collector  
(raised position)

# SRS CHALLENGES

---

- **HIGH POWER FLOW (0.8 MWATT) DURING CHARGING EVENT**
- **LIMITED SPACE AVAILABLE**
- **VARIABLE HEIGHT OVER GROUND WHILE CHARGING**
- **ENSURE A FAST KINETIC (2 SEC. MAX FOR CONNECTION)**
- **SAFETY AND RELIABILITY OVER YEARS OF SERVICE**



# THE CHALLENGE FOR MERSEN

## SHORT LEAD TIME

- 18 months between agreed upon specifications and first deliveries

## EXTEND PORTFOLIO FROM RUNNING CONTACT TO STATIC CONTACT

- Running contact:  
30+ years expertise in pantograph strip, 3rd rail shoe



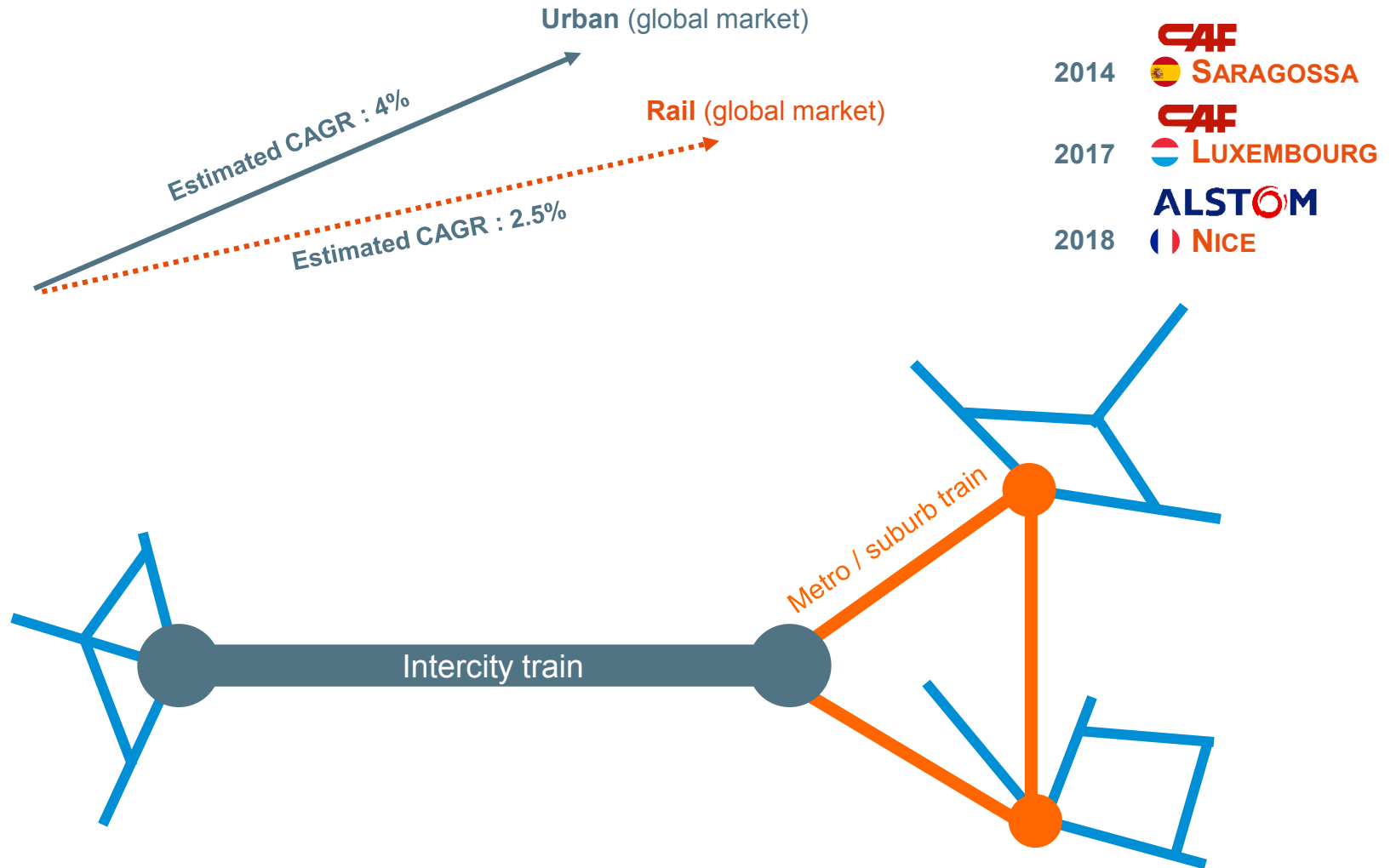
## OUR SOLUTIONS

- Leverage our existing technical know-how
- Collaboration with a specialist in material for static contacts
- Dedicated project team

# TRAM: A DYNAMIC MARKET, WITH A GROWING PORTION OF APS OR SRS FEEDING SYSTEMS

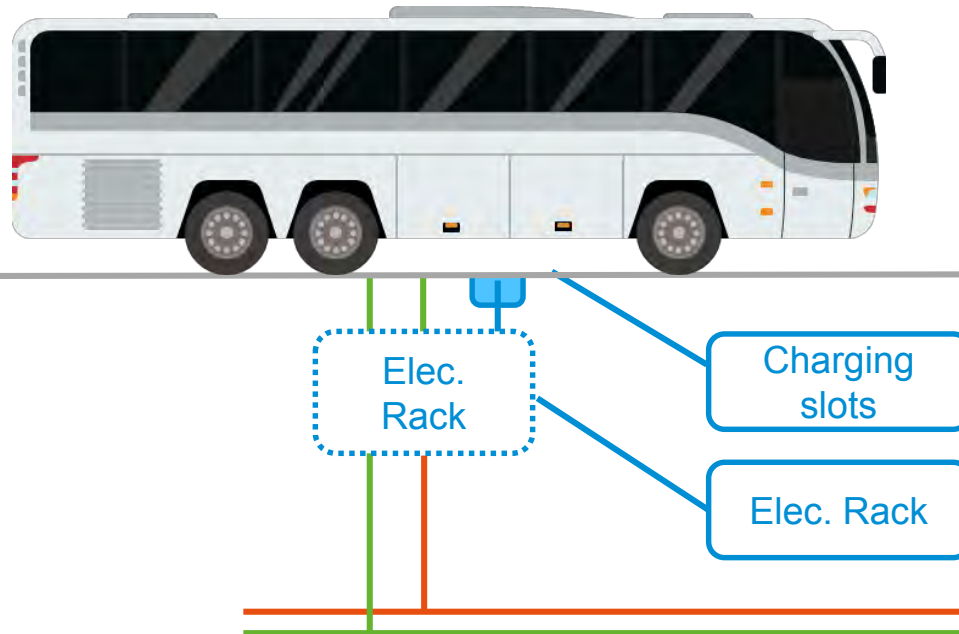
A dynamic market

Driven by the quest of "Interoperable" public transportation systems



# WHAT'S NEXT? ELECTRIC BUSES: THE LAST LINK FOR CLEAN AND DENSE INTEROPERABLE SYSTEMS

## ELECTRIC BUS WITH SRS FEEDING SYSTEM





# A NEW MARKET FOR MERSEN

E-MOBILITY SAFETY CHALLENGES

PHILIPPE ROUSSEL



*Thomas Edison electric car (1913)*

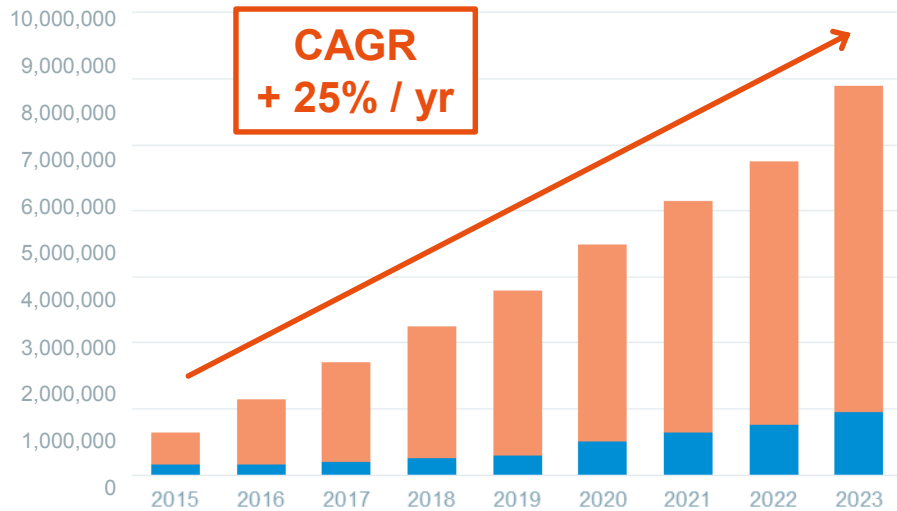
# E-MOBILITY – WHAT’S BEHIND?



- **ELECTRO MOBILITY (E-MOBILITY):** GENERAL TERM FOR THE DEVELOPMENT OF ELECTRIC-POWERED DRIVETRAINS DESIGNED TO SHIFT VEHICLE DESIGN AWAY FROM THE USE OF FOSSIL FUELS AND CARBON GAS EMISSIONS
- **IT INVOLVES SEVERAL FAMILIES DEPENDING ON THE LEVEL OF ELECTRIFICATION:**
  - **BEV** (or EV): Battery Electric Vehicles = 100% electric (e.g.: Renault Zoe, Tesla)
  - **HEV:** Hybrid Electric Vehicles = Internal Combustion Engine vehicle + electric motor (e.g.: Toyota Prius). Recharge on only done when driving. No plug
  - **pHEV:** Plug-in Hybrid = HEV that you can plug-in to recharge the battery
  - **E-truck** includes small urban trucks, construction trucks, airport pushback tractors, special purpose trucks...

# EV/HEV: A BOOMING MARKET FOR BOTH PASSENGER CARS AND HEAVY-DUTY VEHICLES

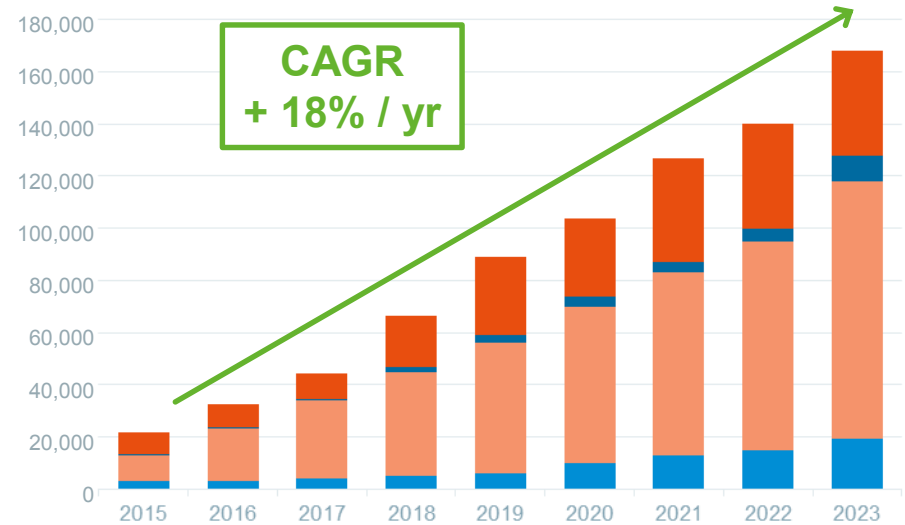
PASSENGER CARS ANNUAL VOLUMES (UNITS)



Passenger HEV Passenger BEV



HEAVY-DUTY VEHICLES ANNUAL VOLUMES (UNITS)



E-truck HEV E-truck BEV E-bus HEV E-bus BEV



Sources: IDTechEx et Yole Development market reports 2015

# MAIN PLAYERS

## PASSENGER CARS VEHICLES MAIN PLAYERS



### BEV 2015 units sold

### HEV + pHEV 2015 units sold

Tesla	49,000	Toyota Prius	631,971
Nissan Leaf	43,000	Toyota Others	308,637
BMW i3	24,300	BYD	40,000
Geely Panda	19,400	Other brands	489,092
Renault Zoe	17,200		
Chevrolet Volt	17,000		
BYD	12,000		
Others	4,000		
<b>Total</b>	<b>185,900</b>		<b>1,469,700</b>

## HEAVY DUTY VEHICLES MAIN PLAYERS



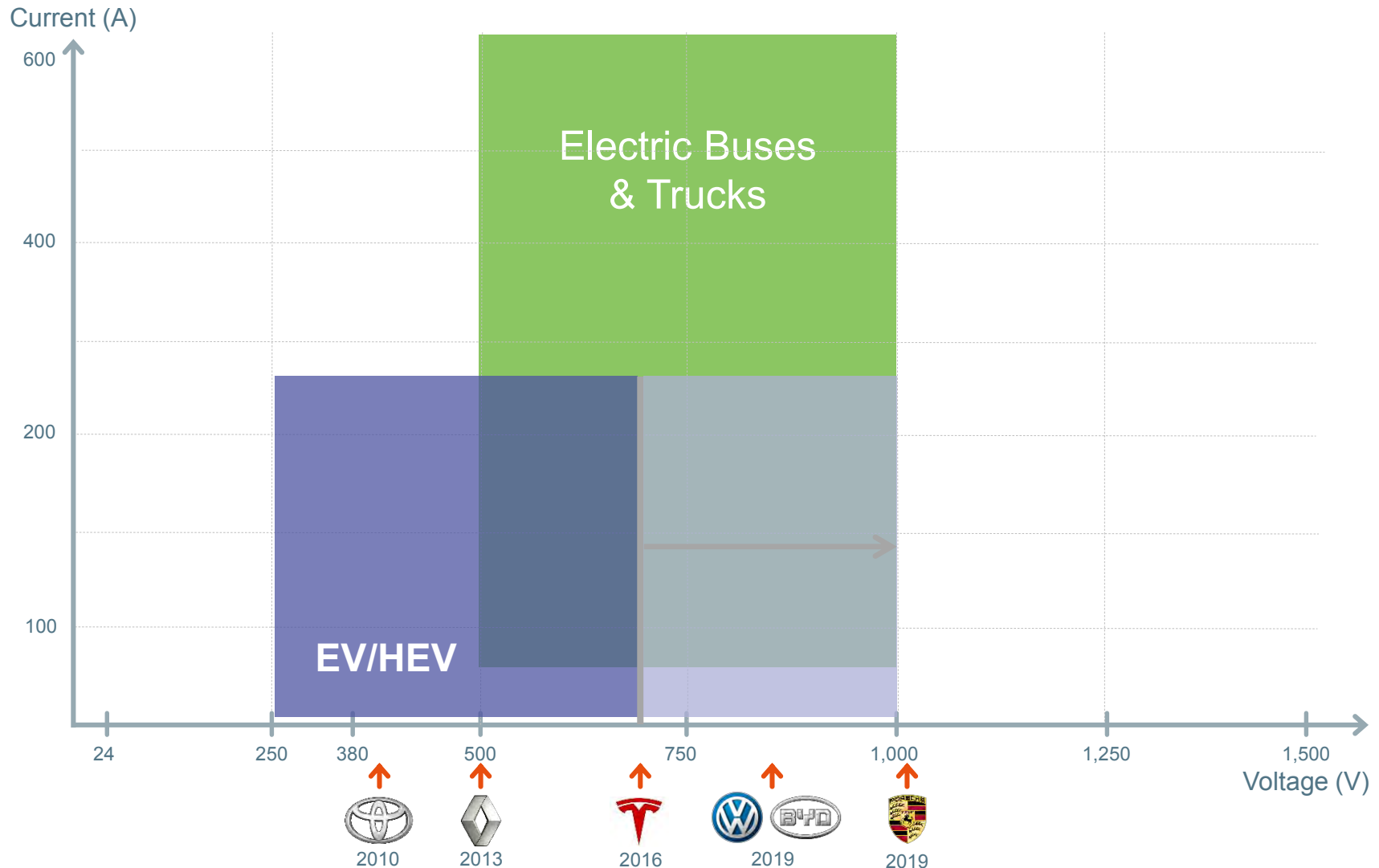
**SIEMENS**





# TOWARD MORE POWER AND MORE AUTONOMY

## EV/HEV NOW TARGETS 1,000 VDC BATTERY PACK VOLTAGE



# NEW CHALLENGE FOR THE INDUSTRY: SAFETY

- **1,000 VDC BATTERY PACK IMPLIES HAVING A DEVICE THAT CAN QUICKLY DISCONNECT THE BATTERY FROM THE REST OF THE CAR**
- **TECHNICAL CHALLENGE :**
  - Open a DC electric circuit, when loaded, will automatically generate hazardous arc flash
  - By essence, an AC current will naturally cross zero during a short period of time. That helps to extinct the arc
  - DC current won't cross zero, arc becomes difficult to extinct: behavior becomes unpredictable
- **... BEYOND 500 VDC, FEW OR EVEN NO SOLUTION EXIST THAT CAN SAFELY AND QUICKLY OPEN A CIRCUIT**

**DISRUPTIVE TECHNOLOGY IS EXPECTED TO MANAGE BATTERY SYSTEMS SAFETY IN THE 500 TO 1,000 VDC RANGE**

# MERSEN ULTIMATE ELECTRICAL DC PROTECTION DEVICE FOR EV UP TO 1,000 VDC: XP SERIES

- OUR SOLUTION: A COMBINATION OF FUSE & PYROSWITCH ASSEMBLED TOGETHER IN PARALLEL / SERIES
- NO ARC-FLASH, ULTRA-LOW POWER LOSS, FEW AGEING: LONG LIFE-TIME, HIGH SELECTIVITY
- PATENT PENDING
- SOLUTION ALREADY PROPOSED BY MERSEN TO:

**XP series®**



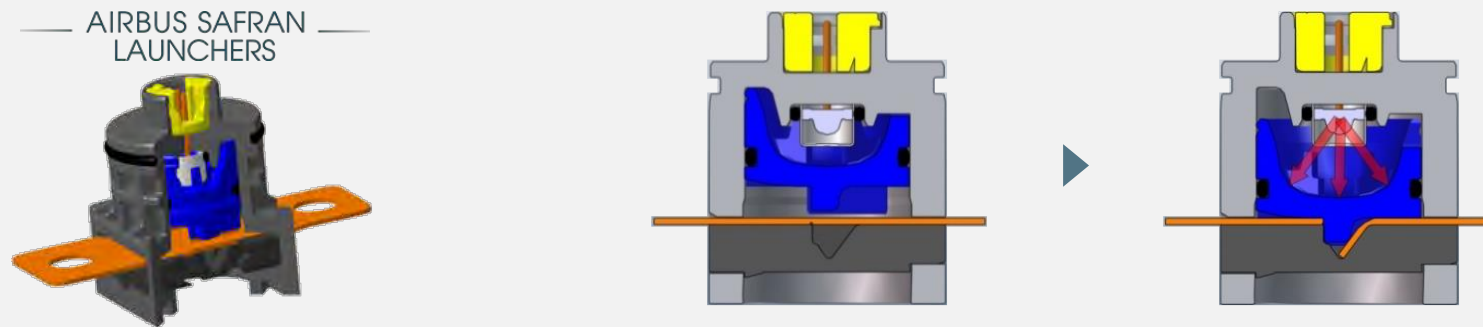
Cars manufacturers



Battery manufacturers



# OUR INDUSTRIAL PARTNER: AIRBUS SAFRAN LAUNCHERS



## ■ PYRO-SWITCH JOINTLY DEVELOPED AND SUPPLIED BY AIRBUS SAFRAN LAUNCHERS (ASL)

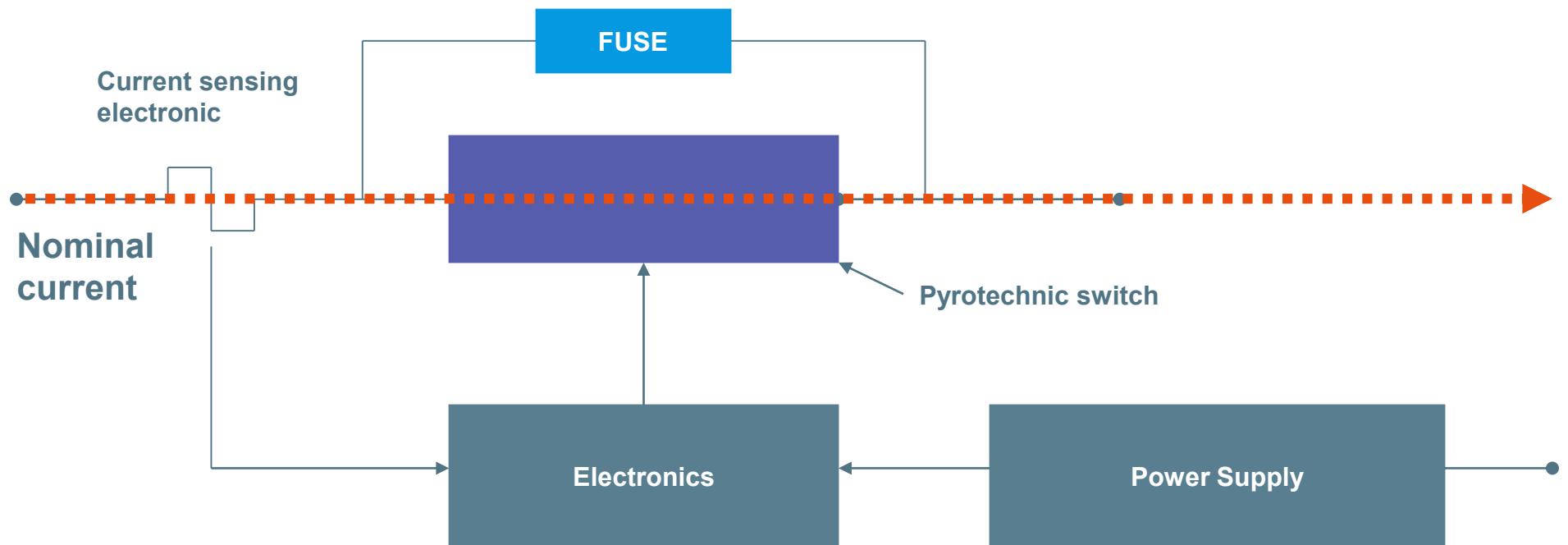
- ASL has a long history in pyrotechnics, already supplying millions of air-bag sub-systems for the automotive world: a proven technology!
- Mersen has signed an exclusive agreement and can freely use the pyroswitch in the  $> 100V$  range whereas ASL can keep on using it in the  $< 100V$  applications

# BASIC PRINCIPLE AND OPERATION (1/3)

## STEP 1

### OVERALL TOPOLOGY & NOMINAL OPERATION CONDITIONS

- The system is based on a pyroswitch in parallel with an undersized rated current fuse
- Under normal operation, most of the current flows through the pyroswitch due to the fuse high resistance compared to the pyroswitch resistance: very few losses

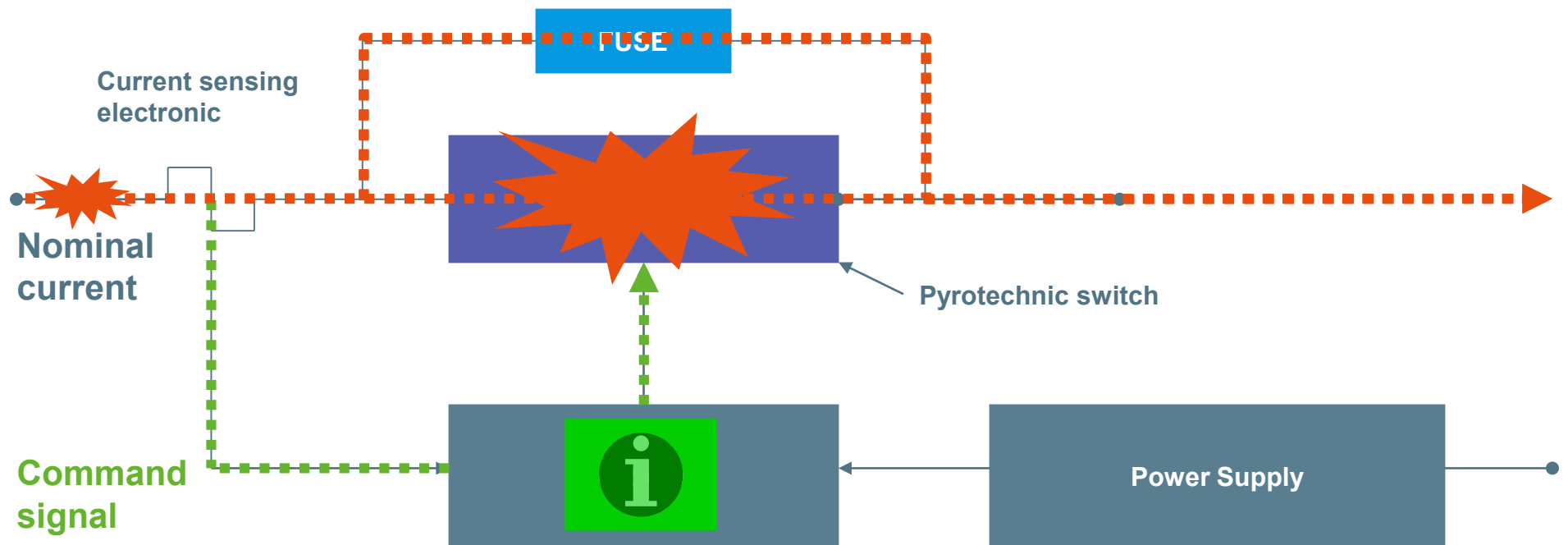


# BASIC PRINCIPLE AND OPERATION (2/3)

## STEP 2

### A CURRENT OVERTSHOOT IS DETECTED BY THE CURRENT SENSOR

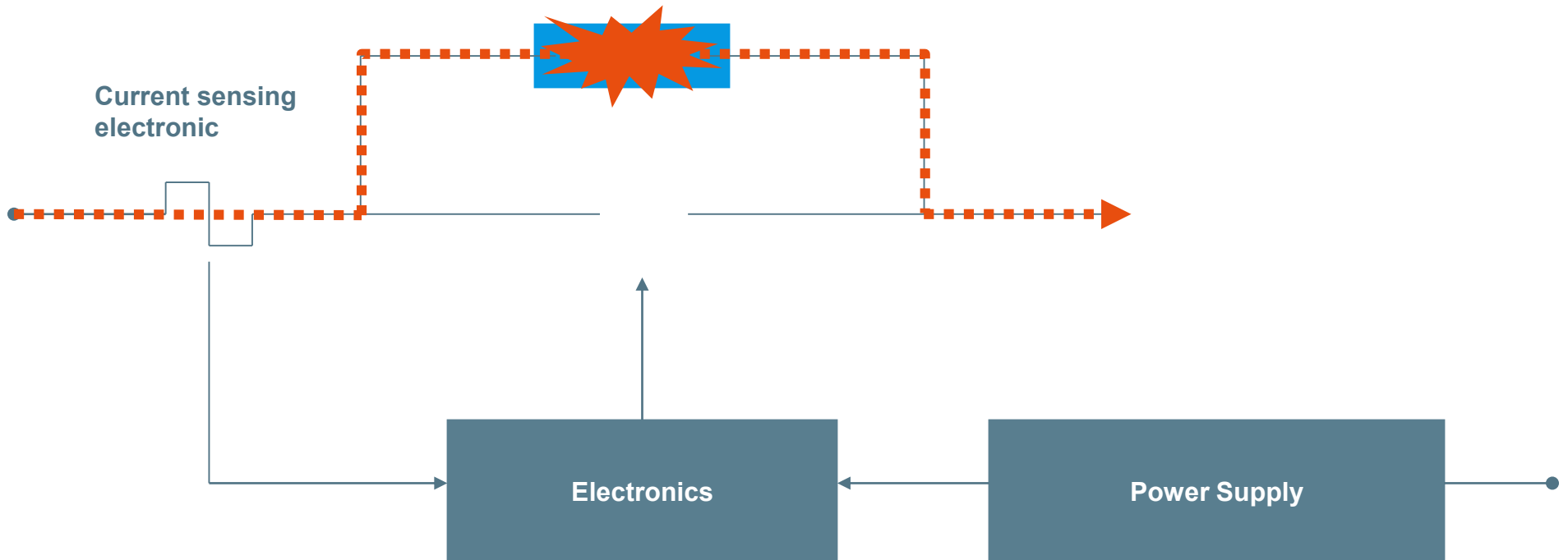
- A signal is sent to the pyrofuse to operate
- The pyroswitch breaks under no voltage (being in parallel with the fuse): No arc
- The default current is transferred to the fuse path



# BASIC PRINCIPLE AND OPERATION (3/3)

## STEP 3 THE CIRCUIT SAFELY OPENS

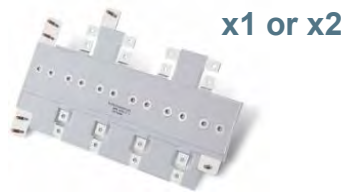
- Due to the large fault current and the undersized fuse, the fuse melts very quickly
- The current is quickly cleared and the circuit is open and safe





# MERSEN OFFER IN EV/HEV: BEYOND Xp, A COMPLETE PRODUCT PORTFOLIO

## PDU



Laminated Busbar and Cooling

## BATTERY PACK



Monitoring Busbar  
Cooling  
plates and Module fuses

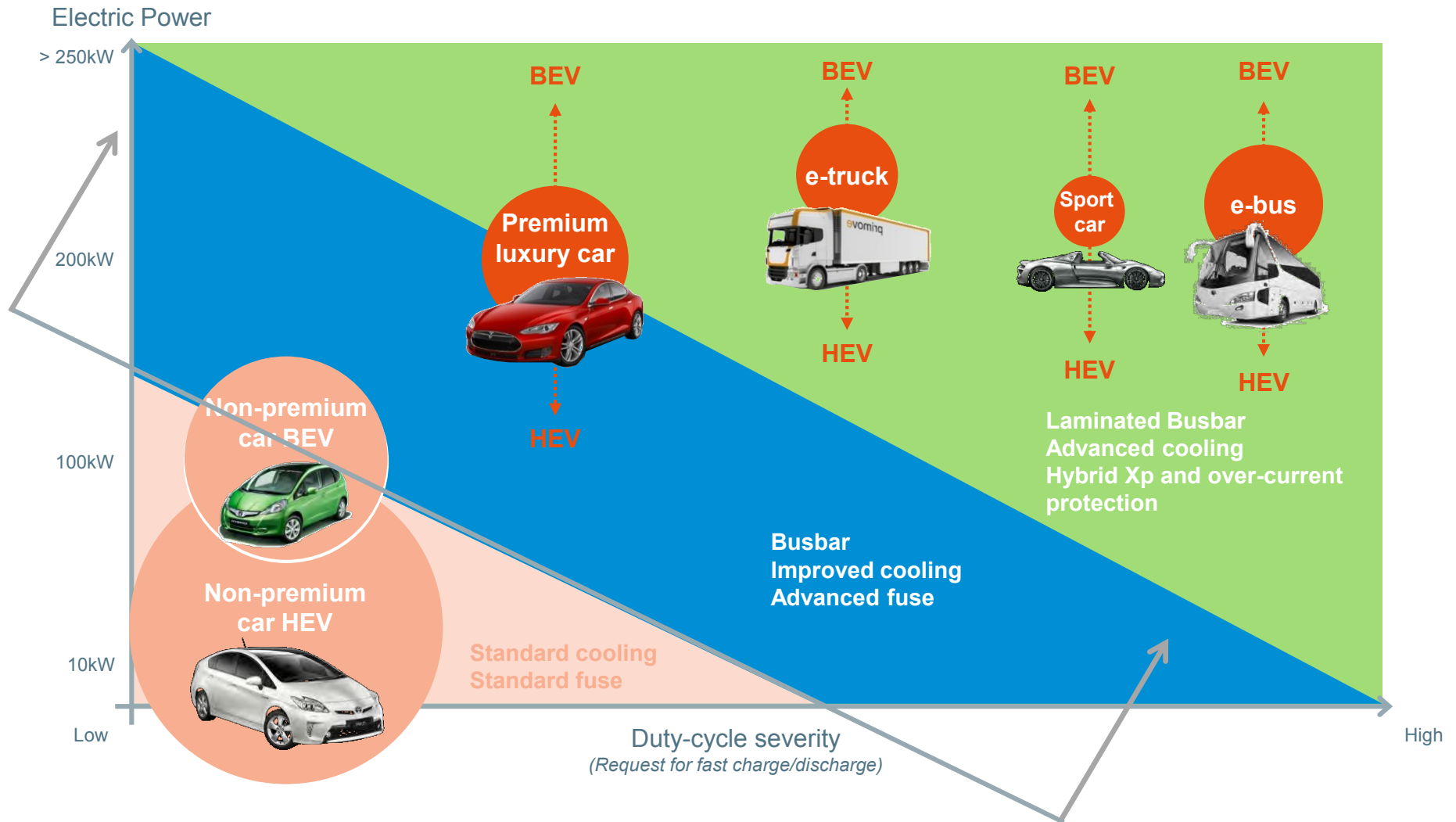
## BDU / MSD



Fuses / Hybrid DC protection (Xs, Xp)

PDU: Power Distribution Unit (Inverter)  
BDU: Battery Disconnect Unit  
MSD: Maintenance Safety Disconnect

# MERSEN OFFER TAILORED TO ANY EV/HEV APPLICATIONS ADDRESSING PERFORMANCE ADDED-VALUES



# CURRENT CUSTOMER IN THE EV/HEV INDUSTRY

## MERSEN FLEX SMART-BUSBAR IN MERCEDES S400 HYBRID



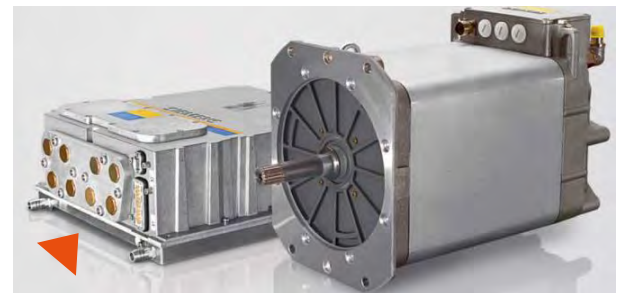
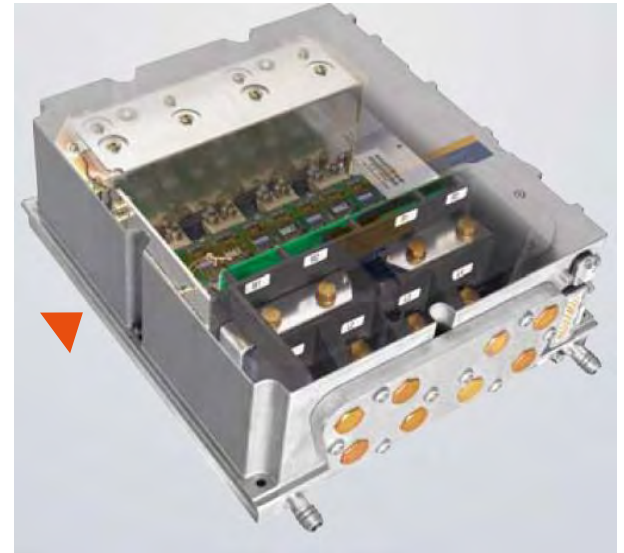
**39** cells in series, **4** Thermal sensors,  
Voltage sensor on each cell by Flex



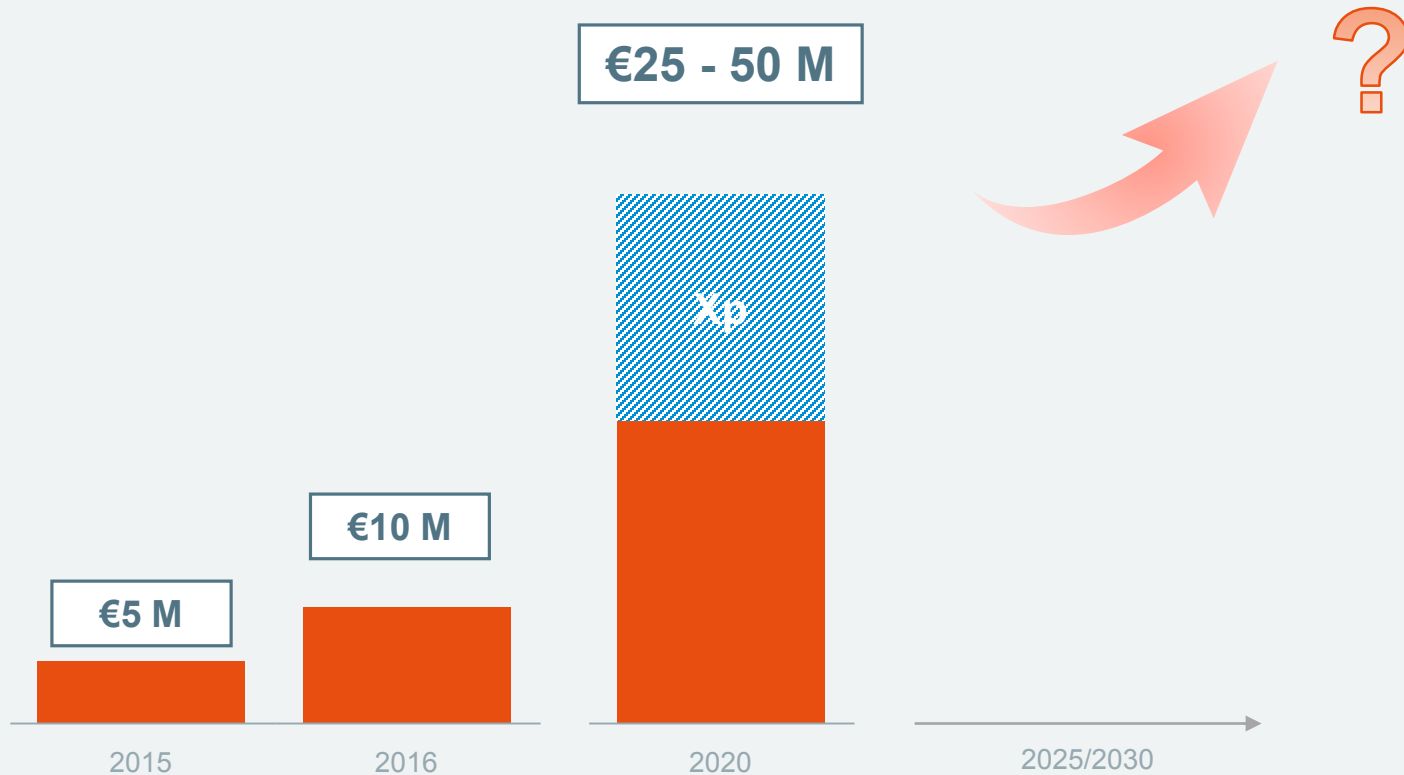
# CURRENT CUSTOMER IN THE EV/HEV INDUSTRY

## MERSEN COOLING-PLATE FOR SIEMENS ELFA HYBRID-BUS DRIVES

Liquid cooling plate for hybrid-bus **50 kW** to **180 kW** motor inverter



# MERSEN POTENTIAL IN ELECTRIC VEHICLES



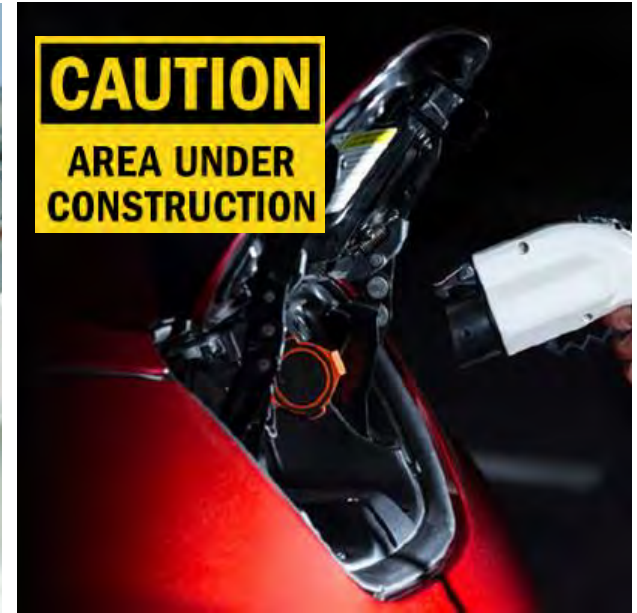
# CONCLUSION



**MARKET AND TECHNOLOGY  
INTELLIGENCE REVEALED  
A CHALLENGE IN EV/HEV**



**R&D AND INNOVATION LED  
TO CREATE A DISRUPTIVE &  
PATENTED TECHNOLOGY: XP**



**EV/HEV IS A MARKET  
UNDER CONSTRUCTION**



AND NOW ...



PORSCHE 918 SPYDER - 2013



TESLA



# QUIZ

NAME : .....

FIRST NAME : .....

E-MAIL : .....

■ QUESTION 1 :           A                           B                           C

■ QUESTION 2 :           A                           B                           C

■ QUESTION 3 :           A                           B                           C

■ TIEBREAKER QUESTION : .....