V2X, The EV Powertrain at the Heart of the Power Grid
Olivier Lobey, Huawei, Nuremberg Research Center, EV Lab

November 24, 2020 – IFPEN – ECAV 2020
V2X,
The EV Powertrain at the Heart of the Power Grid

1. Energy & Transportations
   Overlapping Means & Objectives

2. Huawei
   From Information Technology to Automotive

3. V2X
   Use Cases & Solutions
1. Energy & Transportations

Energy by Sector

Final energy consumption by sector, EU-27, 1990-2018
(million tonnes of oil equivalent)

Remarks:
1 tonne of oil equivalent = 11.63 Megawatt hour

⇒ Transports, and Households, represents more than 60% of Human Energy Needs

Source: Eurostat (online data code: nrg_bal_c)
Remarks: 1 tonne of oil equivalent = 11.63 Megawatt hour
1. Energy & Transportations

Energy Strategy Transformation

Sources: Bloomberg, New Energy Outlook

⇒ Solar & Wind to Become the Major Energy
1. Energy & Transportations

Energy Strategy Transformation

**China**
- Carbon neutral realized **in 2060**
- Peak value **by 2030**, 20% renewable energy

**EU**
- Carbon neutral realized **in 2050**
- GHG emission reduced 60% **by 2030**, 32% renewable energy

Strategic transformation of energy giants
- Accelerate Carbon Neutral realized

Various Power consumption companies join RE100
- Promised to achieve 100% renewable energy power consumption

⇒ The Governments & Large Corporations continuously specify low carbon targets
1. Energy & Transportations

Renewable Energy Penetration Rate & Weakened Grid Strength

Grid strength weakened by mass RE installation

Limited Grid support capability of existing Inverters

| SCR estimated based on renewable energy penetration rates released by Bloomberg, New Energy Outlook |
| Grid strength is mainly affected by the Renewable energy penetration rate of the local grid. |

<table>
<thead>
<tr>
<th>Traditional Energy</th>
<th>Traditional PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response time of Vol. adjustment</td>
<td>~ 5ms</td>
</tr>
<tr>
<td>Response time of Freq. adjustment</td>
<td>10s-level</td>
</tr>
<tr>
<td>Min. supported SCR</td>
<td>Synchronous Generator</td>
</tr>
<tr>
<td>Power quality - THDi</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>

Inverter terminal SCR of strong grids
Inverter terminal SCR of weak grids

2019.08 UK
Black out caused by Lighting

2020.05 India
New grid code put into effect

2020.06 Spain
NTS required terminal to support SCR=1.5
1. Energy & Transportations Electrification Outlooks

Source: IEA 2019. All rights reserved. Notes: The cumulative sales shown in this figure are based on OEMs announcements on the number of EVs deployed in a target year and then extrapolating these values for the following years using a range of assumptions. The number of electric vehicles deployed by each OEM in its target year is calculated taking into account three possible inputs: i) an absolute target value of EV sales given by an OEM; ii) a target value expressed in terms of models deployed; or iii) a targeted percentage of the OEM sales.

* With an average of 30kWh/vehicle

V2X,
The EV Powertrain at the Heart of the Power Grid

1. Energy & Transportations
   Overlapping Means & Objectives

2. Huawei
   From Information Technology to Automotive

3. V2X
   Use Case & Solutions
2. Huawei: Part of 50 Most Innovative Companies of 2020

<table>
<thead>
<tr>
<th>Rank</th>
<th>Company</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10</td>
<td>Apple</td>
<td>+2</td>
</tr>
<tr>
<td></td>
<td>Alphabet</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>Amazon</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>Microsoft</td>
<td>+0</td>
</tr>
<tr>
<td></td>
<td>Samsung</td>
<td>+0</td>
</tr>
<tr>
<td></td>
<td>Huawei</td>
<td>+42</td>
</tr>
<tr>
<td></td>
<td>Lenovo</td>
<td>+16</td>
</tr>
<tr>
<td></td>
<td>IBM</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>Sony</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Facebook</td>
<td>-2</td>
</tr>
<tr>
<td>11-20</td>
<td>Tesla</td>
<td>-2</td>
</tr>
<tr>
<td></td>
<td>Cisco</td>
<td>+5</td>
</tr>
<tr>
<td></td>
<td>Walmart</td>
<td>+29</td>
</tr>
<tr>
<td></td>
<td>Tencent</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>HP</td>
<td>+29</td>
</tr>
<tr>
<td></td>
<td>Netflix</td>
<td>-11</td>
</tr>
<tr>
<td></td>
<td>LG</td>
<td>-0</td>
</tr>
<tr>
<td></td>
<td>Intel</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Dell</td>
<td>+21</td>
</tr>
<tr>
<td>21-30</td>
<td>Siemens</td>
<td>-5</td>
</tr>
<tr>
<td></td>
<td>Target</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Philips</td>
<td>+6</td>
</tr>
<tr>
<td></td>
<td>Xiaomi</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Oracle</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>UPS</td>
<td>-12</td>
</tr>
<tr>
<td></td>
<td>SAP</td>
<td>+1</td>
</tr>
<tr>
<td></td>
<td>Adidas</td>
<td>-18</td>
</tr>
<tr>
<td></td>
<td>Hitachi</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Costco</td>
<td>-</td>
</tr>
<tr>
<td>31-40</td>
<td>JD.com</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Volkswagen</td>
<td>+6</td>
</tr>
<tr>
<td></td>
<td>Bosch</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Airbus</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Salesforce</td>
<td>-2</td>
</tr>
<tr>
<td></td>
<td>JPMorgan Chase &amp; Co.</td>
<td>-16</td>
</tr>
<tr>
<td></td>
<td>Uber</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Bayer</td>
<td>-14</td>
</tr>
<tr>
<td></td>
<td>P&amp;G</td>
<td>-10</td>
</tr>
<tr>
<td>41-50</td>
<td>Toyota</td>
<td>-4</td>
</tr>
<tr>
<td></td>
<td>ABB</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3M</td>
<td>-5</td>
</tr>
<tr>
<td></td>
<td>Unilever</td>
<td>-13</td>
</tr>
<tr>
<td></td>
<td>Fiat</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Novartis</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Coca-Cola</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>McDonald's</td>
<td>-29</td>
</tr>
</tbody>
</table>

Remarks: (+/- N) indicates change in position from MIC of 2019, no change noted for new entrants.

Source: BCG Global Innovation Survey
2. Huawei: Business Scope

- **Hundreds of millions of consumers**
- **Global carriers**
- **Global enterprises, Automotive and industries**

- **CBG**
  Products & Services
  Iconic global technology brand

- **CNBG**
  Products & Services
  Best strategic partner for carriers

- **EBG**
  Products & Services
  Enabler and preferred partner for digital transformation

- **Cloud BU**
  Products & Services
  Cloud partner with reliable, trusted, evolvable services

- **IAS BU**
  Products & Services
  In-vehicle solutions with ICT competencies

---

5 Main Business Units

<table>
<thead>
<tr>
<th>Smartphones &amp; Devices</th>
<th>4G/5G Infrastructure</th>
<th>Smart Factory</th>
<th>Data Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphones</td>
<td>Wireless networks</td>
<td>Enterprise networks</td>
<td>Data center infrastructure</td>
</tr>
<tr>
<td>MBB &amp; home appliances</td>
<td>Fixed networks</td>
<td>IoT connection management platforms</td>
<td>Big data analytics</td>
</tr>
<tr>
<td>Wearables</td>
<td>Carrier software</td>
<td>AI platforms</td>
<td>AI platforms</td>
</tr>
<tr>
<td>Other devices</td>
<td>Core networks</td>
<td>Core networks</td>
<td>Core networks</td>
</tr>
</tbody>
</table>

5 Main Business Units

- Smartphones
- MBB & home appliances
- Wearables
- Other devices
- Wireless networks
- Fixed networks
- Carrier software
- Core networks
- Enterprise networks
- IoT connection management platforms
- Data center infrastructure
- Big data analytics
- AI platforms
- Cloud services
- gPaaS
- Cloud OS
- Autonomous driving
- Connectivity
- SDV
- E-Powertrain

2. Huawei: Intelligent Automotive Solution

- Huawei proprietary AI chips, computing platforms, and operating systems (OSs)
- Architectures featuring vertical integration and sustainable evolution
- Device-cloud synergy and continuous optimization of scenarios in China

- In-car Ethernet gateway
- Huawei proprietary chips, modules, and T-Box
- 4G/4.5G/5G/C-V2X technologies

- Long range, fast charging, safety, and intelligence
- Efficient powertrain system
- Highly reliable battery management system
- Multi-form charging solutions featuring high and low voltages and high efficiency

- Connection between people, cars, and homes, providing portable services
- Seamless transfer of data between phones and head units to ensure a consistent experience
- Open and neutral service ecosystem

- Design simulation
- Intelligent manufacturing
- Smart marketing
- IoV cloud service
- AD training
2. Huawei: mPower, Extension of Mature Products and Technology

- **Telecom power & BMP/CP**
  - AC→DC Module
  - DC→DC Module
  - + Automotive grade design and verification

- **Solar Inverter**
  - DC→AC Module
  - + Automotive grade design and verification

- **Telecom Blade Li-Battery Huawei Cell Phone Battery Management**
  - + Automotive grade design and verification

- **OBC**

- **MCU**

- **BMS**
2. Huawei: mPower Portfolio

mPower solutions

- **BMS**
- **CloudBMS**
- **OBC**
- **Charge module**
- **Wireless charger**
- **ePowertrain [incl. MCU]**

### Security
- Functional Safety
- Battery Safety

### Reliability
- From design to manufacturing

### Intelligence
- Enhancing user experience

### Efficiency
- Focus on high efficiency
V2X,
The EV Powertrain at the Heart of the Power Grid

1. Energy & Transportations
   Overlapping Means & Objectives

2. Huawei
   From Information Technology to Automotive

3. V2X
   Use Case & Solutions
3. V2X
Automotive Powertrain Market Drivers

a. 7 Market Drivers defines Automotive Powertrain;
b. Priorities can change over time,
c. as long as thresholds are achieved for the others,
d. with only one exception:
e. Highest Appealing Factor is a must.
3. V2X
Use Cases for All-in-One Charging

Universal AC Charging

HV spare battery

V2L

V2G and V2H DC

V2V AC and DC outputs

V2V DC input

Portable Charging Unit

DC Charging

Packaging and Functionality
Fully Integrated

AC Connector

On-Board Charger + DC/DC Converter

LV Battery

LV DC Auxiliary Charging

Wireless charging

On-Board Charger

+ DC/DC Converter

LV DC Auxiliary Charging

Wireless charging

Solar Roof

Remarks:
V2V: Vehicle to Vehicle
V2G: Vehicle to Grid
V2H: Vehicle to Home
V2L: Vehicle to Load
3. V2X
Efficient & Safe Wireless Charging System for Easier EV Adoption

Wireless Charging System

- GA Controller
- VA
- GA Coil

- Power level: 11 kW
- Output voltage: 280–450 V
- VA power density: 2.1 kW/L

Efficient: Up to 93% charging efficiency
- Efficiency under over all range > 90%

- Reduce power transformation stages
- Efficiency optimization algorithm
- Constant frequency control

Safe: detection of live objects/metals, low radiation
- Multi-effect recognition algorithm can detect metal: diameter ≥ 2mm
- Less electromagnetic radiation than household appliances

Accurate: Position detection error ≤ 2 cm*
- Wireless charging and automatic parking convergence
- Intelligent algorithm adaptive to metal/non-metal shielded environments

Note: The horizontal distance between VA and GA Coil is less than 30 cm, and the avg. detection error is less than 2 cm.

Better compatibility, multiple adaptations
- GA designed for VA among 3.7~11kW
- GA designed for Z level among 100~250mm

Z1: 100-150mm
Z2: 140-210mm
Z3: 170-250mm

Efficiency/%

<table>
<thead>
<tr>
<th>Measurement Point</th>
<th>Efficiency/</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>94</td>
</tr>
<tr>
<td>2</td>
<td>93</td>
</tr>
<tr>
<td>3</td>
<td>92</td>
</tr>
<tr>
<td>4</td>
<td>91</td>
</tr>
<tr>
<td>5</td>
<td>90</td>
</tr>
<tr>
<td>6</td>
<td>94</td>
</tr>
<tr>
<td>7</td>
<td>93</td>
</tr>
<tr>
<td>8</td>
<td>92</td>
</tr>
<tr>
<td>9</td>
<td>91</td>
</tr>
<tr>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>11</td>
<td>94</td>
</tr>
<tr>
<td>12</td>
<td>93</td>
</tr>
</tbody>
</table>

*Accuracy up to ±2 cm
3. V2X
V2H, in a smarter way?

State-of-the-art

Resulting efficiency from PV panel [stored energy] to the HV battery:
84% => To be improved!
### Shimane, Japan

- **Capacity:** 11MW
- **COD:** 2017.03.01
- **EPC:** Power Max Co., Ltd

<table>
<thead>
<tr>
<th>Phase</th>
<th>Capacity (DC)</th>
<th>Inverter</th>
<th>Yields of April / Wh</th>
<th>Unit Yields</th>
<th>Huawei Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I</td>
<td>11MW</td>
<td>Central</td>
<td>1417290</td>
<td>809.325</td>
<td>/</td>
</tr>
<tr>
<td>Phase II</td>
<td>12MW</td>
<td>Huawei SUN2000-28KTL</td>
<td>1569040</td>
<td>854.596</td>
<td>5.59%</td>
</tr>
</tbody>
</table>
SPARK YOUR INNOVATION.
CONVERT YOUR IDEAS.
LEAD THE CHARGE.

15,000 € in cash prizes

1. High-Efficiency DC-DC Converter for Automotive Applications
2. High-Efficiency Isolated Boost Inverter Design
3. Medium Distance Wireless Charging
4. Parallel Connection and Control of SiC MOS and IGBT

https://powerup-huawei.bemyapp.com/#/event
Thank you!

Acknowledgments:

- Eduardo Facanha de Oliveira
- Siddharth Agrawal
- Roland Huempfner
- Hariram Subramanian
- Chen Chen
- Gao Jing

For More Information:

- Olivier Lobey
  奥礼文
  Technical Lead, EV Powertrain Lab
  Nuremberg Research Center
  HUAWEI TECHNOLOGIES Duesseldorf GmbH
  Suedwestpark 48, 2G, 90449 Nuremberg
  Email: olivier.lobey@huawei.com
  Fax: + 49 89 1588344134
  Mobile: +49 159 0445 0781
The information in this document may contain predictive statements including, without limitation, statements regarding the future financial and operating results, future product portfolio, new technology, etc. There are a number of factors that could cause actual results and developments to differ materially from those expressed or implied in the predictive statements. Therefore, such information is provided for reference purpose only and constitutes neither an offer nor an acceptance. Huawei may change the information at any time without notice.