PTR Insights
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Eroding Prices & Tough Competition: Today’s T&D Equipment Market

Eroding prices of power equipment, and the increasing competition are well-known dilemmas in the market today. The T&D equipment market is large (~$220B) albeit highly saturated. This is especially true for medium voltage equipment with local manufacturers making gains in market share in countries across the world. Large established players, operating in multiple regions across the globe are facing tough competition, especially from a price perspective, from emerging Chinese, Indian and Turkish suppliers.

In recent years, Asian manufacturers have made significant gains in global market share, due to wins in emerging markets. Initiatives like One Belt One Road, providing funding for infrastructure projects, are giving Chinese manufacturers a very strong advantage. Today, low cost competition is the most eminent threat to established T&D suppliers globally. It is crucial for equipment manufacturers to align their strategies accordingly, to sustain their position in the market, or risk losing more business.

How can this challenge be addressed? Step one is to differentiate between markets and adopt tailored strategies for each country, as opposed to a broader regional strategy. The difference between high growth markets focused on electrification (more greenfield projects) and stable markets, heavy on replacement, is a simple, yet important factor the successful take advantage of. In growth markets, keeping an eye on pricing and offering products at lower margins, in addition to local partnerships can put a manufacturer in a very strong position. In addition to that, cooperating with international funding agencies for large scale infrastructure projects, involving advanced technologies (HVDC, FACTS etc.) is also a sustainable growth mechanism in these markets. For stable markets however, equipment demand is driven by maintenance and replacements. In these markets, focus on providing cutting-edge digital services to support utilities in reducing their OPEX spends, and at the same time helping utilities execute global on mega-trends, like integration of DERs(incl. Electric Vehicles) and technologies like 5G, and their impact on grid, is the way to put a company at the forefront of regional development.

The difficulty for manufacturers today is aligning themselves to this changing environment, while keeping utilization at maximum. Pragmatically, both these targets align well for sustainable growth of the business. For this, credible strategic market information is of more value than ever before.

In this issue, we focus on some of these leading trends for various equipment types. Please enjoy reading and give us your feedback on how can we improve it to make it more useful to you.

Hassan Zaheer
Co-Founder & Principal Consultant
May 2019
Conversor Transformers Market Analysis

By Saqib Saeed & Saifa Khalid

HVDC converter transformers, we estimate, will become $5.3 billion market by 2025 at a CAGR 18-25 of approximately 18%. With more and more generation being distributed unevenly and often at long distances from load centers (e.g. offshore wind), AC transmission systems are being replaced by DC transmission to avoid losses and reactive power issues. Moreover, interconnected AC power grids at different frequencies across countries (e.g. in Europe) makes HVDC a highly reliable solution for transporting energy between two asynchronous systems.

An HVDC system consists of two or more converter stations connected with a transmission medium (underground/subsea cable or over-head line). A converter station is equipped with following sub-components depending on the technology:

1) Converter transformers
2) Converter valves
3) Filters (AC and DC)
4) Smoothing reactors
5) Reactive compensation
6) Control & protection

The most important component out of these is the HVDC converter transformers; their efficiency and reliability play an extremely important role in the overall functioning of the system. Since converter transformers acts as the interface between AC and DC systems, it must fulfil superimposed requirements related to AC and DC systems.

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Converter Transformers Market:
HVDC is a mature technology with hundreds of projects installed and several projects in planning. As a result, the global HVDC converter transformer market has also gained remarkable momentum during the last few years. More than 700 single-phase two-winding transformers were installed in more than sixty HVDC projects commissioned around the globe in the last five years.

Market Size:
According to Power Technology Research, the HVDC converter transformer market is projected to reach $5.3 billion by 2025 at a CAGR of approximately 18%. The market is mainly driven by new installations of HVDC systems for new off-shore wind systems and long-distance power transfer to load centers, however refurbishments also plays a significant role.

Regional Dynamics:
APAC is expected to be the largest market for converter transformers. Transmission infrastructure in APAC is being developed accounting for more than one third of the total market in the last few years. In the next 5 years, around 62% of the total new converter transformers capacity is planned to be installed in APAC. Chinese market alone is the largest factor behind this with 53% of planned converter transformer installations expected in the country.

EEMEA is the second largest market by capacity of converter transformers at 24% followed by Americas at 14%. Most of these installations are going to be HVDC connection of off-shore wind projects expected to come online in Germany and UK, followed by grid interconnection projects in Europe, GCC and South America.

Key growth drivers of global converter transformers market in the future are expected to be:

• Increasing addition of generation away from demand centers in APAC, especially in countries like China, India and Indonesia.

• Cross-border grid interconnection projects between countries within Europe, GCC and South America.

• Integration of renewables, including off-shore wind in Europe, especially in UK and Germany.

• Electricity import from MENA to European demand centers (e.g. EU-GCC clean energy)
A key challenge for system operators (utilities) has been multi-vendor interoperability of HVDC converter stations. HVDC systems are provided as a turnkey solution to system operators. However, utilities expect to be able to install HVDC converters from different manufacturers in one multiterminal project. A multivendor solution, if made possible, can also result in a cost competitive environment bringing HVDC prices down. An exception to this scenario is converter transformers, especially in China, where most of the converter transformers projects are split into multiple manufacturers due to the sheer size of the order.

Supply Landscape:
HVDC converter transformer supply side had been dominated in the past by western players like ABB and Siemens. Initially, APAC remained dependent on the external players for HVDC equipment including converter transformers. But continued R&D efforts coupled with policies around domestic content requirements have resulted in partnerships between HVDC converter manufacturers and local players, enabling local players to capture a significant amount of market share. Some of the leading players in the global HVDC
converter transformer market today are ABB, Siemens, GE-Alstom, BHEL, TBEA, XD transformers, NR Electric, RXPE and C-EPRI. ABB and Siemens still have the largest market share of HVDC systems globally and are well positioned to win projects across the world.

**ABB Power Systems:**
ABB has the largest installed base of projects around the world. To this date, ABB has supplied more than 550 converter transformers globally. Due to their specific focus on Asian markets, where they work in partnership with local companies, they have been able to maintain a leading position in the market.
In the recent years, they have divested from the cables business and have expanded their R&D spend to focus on the core competency of converter station manufacturing. The group’s recent acquisition by Hitachi (still to be completed in two years) is however something to be keenly tracked and will certainly result in changing supply side dynamics of HVDC converter transformers market.

**Siemens Energy Management:**
Siemens Energy Management division is also a strong contender of the HVDC market share. In recent years, Siemens has been focusing on supplying its VSC technology to the market. With key focus on western markets, Siemens has been winning HVDC tenders in Europe. The division is also well positioned to win connection projects of off-shore wind power plants in Germany, UK and Americas.

**Conclusion:**
HVDC converter transformers market outlook is promising in the next five years. The HVDC transmission market itself is projected to reach approximately $13 billion by 2024 fueling the HVDC converter transformer market resultantly. Along with APAC, we can see impressive expansion and development plans of HVDC technology in the EMEA and Americas depicting healthy industry growth in the coming years. Medium Voltage DC technology is also expected to penetrate lower voltages, medium voltage DC (MVDC), eventually turning into a big opportunity as more and more utilities across the world install MVDC systems.

Lack of multi-vendor interoperability is expected to continue, with converters on both sides still sourced from same supplier, however, for other components like transmission medium, reactive compensation equipment and converter transformers can be sourced from different manufacturers. So HVDC, seemingly a highly consolidated market, offers opportunities for tier-2 players as well. This also provides a new market for component suppliers such as bushings, sensing, control and protection equipment for transformers. Moving forward, PTR anticipates that the market will become less consolidated with more players emerging from Asian markets.

**About our Project Specific HVDC Research**
Evolution of Li-Ion Batteries: From the Garage to the Grid?

By Hassan Zaheer

Li-Ion with all its variants is the most used battery type today. It has a commanding 40% share among different battery types, which is expected to grow even more in the future due to increased use in EVs and consumer electronics.

Recent Technical Advancements and Market Trends:
E-mobility, consumer electronics and other applications are spurring new research in the battery manufacturing sector. The following are some recent advancements and trends in Li-Ion battery technology, which are expected to have a significant impact on market dynamics:

Solid-State Batteries:
One of the most actively discussed topics in the energy storage industry is the variant of Li-Ion technology, using solid electrolytes instead of liquid/polymer electrolytes. Solid-state batteries offer some key advantages over conventional Li-ion. This includes a very high energy density, compact cell size between 3-4 microns (instead of 20-30microns), and a possibility of quick charging without the risk of dendrites formation.

All of this makes it a very lucrative option for the automotive industry, which is looking for batteries able to withstand very high charging rates to reduce charging time for EV owners, and at the same time reduce space requirements in the car. This is why some key manufacturers are already looking into using these batteries. BMW is considering the use of solid-state batteries for their newer models and Toyota is planning to produce vehicles with solid-state batteries by 2022. These are the batteries that will be on our roads and parked in our garages in massive numbers going forward.

Non-Copper Anodes:
Another recent advancement in energy storage technology is the non-copper anodes for the battery. Since the 1990s, graphite coated copper has primarily been used as an anode in Li-Ion batteries, but two anode types have the potential to
replace copper anodes moving forward:

**Lithium Titanate (LTO) Anode:**
LTO anodes have a higher power density and can afford a higher number of charging/discharging cycles. These anodes operate on lower voltages and provide low energy density. This makes them ideal for applications with less space constraints while requiring high charge/discharge rates as in grid applications requiring high power density (frequency regulation, renewable integration), where multiple batteries can be combined in a system without strict space saving requirements. Recently, Toshiba announced its 50Ah prototype of this battery which claims to retain 90% of its capacity after 5000 cycles.

**Silicon Anode:**
Another type being researched on is a silicon anode coated with graphite. This anode technology offers high energy density and power rating potential while at the same time promising a lower cost. Samsung SDI and Panasonic are already working with this technology for their batteries. However, this technology is still in its early stages and would need a longer time-to-market than LTO anodes.

**NMC-811 Cathode to Dominate Li-Ion market:**
Nickel Manganese Cobalt (NMC) based cathodes will increasingly replace Lithium Iron Phosphate (LFP) and Lithium Cobalt Oxide (LCO) cathodes. So far, the reluctance of using this blend of cathode material was coming from a higher Cobalt requirement. However, NMC-811 (8 parts Nickel, 1 Manganese, 1 Cobalt) with its reduced dependency on Cobalt is offering a strong advantage to the manufacturers. Many companies are now making a shift towards NMC-811. For example, LG Chem and SK Innovation are ramping up their NMC-811 production capacity, while Tesla is already using this cathode technology in its Tesla Powerwall.

**Use of nanomaterials (Graphene):**
Graphene, a nanomaterial, is being increasingly researched on for use in battery cells. Some properties of graphene, like hardness, flexibility, and very high thermal and electrical conductivity make it advantageous to use in battery cells. Most recently Samsung SDI had a breakthrough with their “Graphene Ball Technology”. Both anode and cathode were covered with graphene-silica protective layer. Samsung SDI claims that using this technology increased the battery capacity by ~45% with a 5x quicker charging time. Toyohashi University in Japan has also proposed phosphorous encapsulated Nano-tube electrodes which are claimed to have doubled charging capacity during experimentation, and the cells maintained high structural integrity after repeat charges.

**Custom Cells and Modules:**
Another emerging niche in the battery market is the design and manufacture of customized Li-ion cells and modules for special applications. Li-Ion used in e-mobility and consumer electronics is just one piece of the market, and there are a
whole range of applications from robotics to marine & defense where standard Li-ion batteries do not suffice. Some manufacturers like Customcells and Cell-con are focusing on this growing niche and work with customers from the prototype to manufacturing stage to produce application specific battery modules for these applications.

**Raw Material Supply:**
One constraint being faced by battery manufacturers is raw material sourcing. The primary raw materials used in Li-Ion batteries are Lithium, Cobalt, Graphite, Nickel and Aluminum. Some say, Lithium and Cobalt are considered scarce. But is this concern really warranted?

Prices for Cobalt have skyrocketed since the middle of 2016, reaching over $80K per metric ton (MT). Looking back a bit further, the current prices were replicated in 2008 when DRC placed a moratorium on exports and prices went up to $115K/MT before the ban was lifted. The country continues to yank the prices around with the latest royalty raising from 2% to 10% in January.

**Cobalt:**
Nearly all cobalt is mined as a byproduct of other more abundant metals, such as nickel or copper. This means production is driven primarily by the markets for the principal metals, not by the need for cobalt. This situation limits producers’ flexibility in adjusting the amount of cobalt mined in response to changes in demand and can result in periods of oversupply or shortage. From 2009 to 2015, global cobalt production was higher than consumption, as production from new projects and from expansions to existing operations added to global supply. This, however, changed and by the middle of 2016, as rising battery demand created a supply constrained market existing through early 2018, forecasted by industry observers to continue through 2020.

The main supplier of Cobalt globally is the Democratic Republic of Congo (DRC) which has a commanding 51-53% of supply based on EU or USA data. This is followed by other countries such as China, Russia, Canada, and Australia at 5-6% each.
2018. However, the price of Cobalt is diminishing in importance to many EVs. This can be confirmed as China, the main user of LCO in EV applications is now being displaced by ternary cells, consisting of LMO, NCA, and NMC. Within the NMC class of batteries, the 811 blend, with 50% less Co required than the 622, is becoming mainstream with LG Chem and NK Innovation setting up new production lines over the last 6 months.

**Lithium:**
Lithium has been listed as one of the critical or near-critical elements in various studies. Between 1975 and 2005, worldwide lithium production increased by a factor of about five, and more growth in the supply base is anticipated. Although produced largely in Australia, the lithium triangle (Argentina, Chile, and Bolivia) hosts 75% of the world's Lithium resource with Chile the leader in extraction from brine.

**End-of-life Recycling:**
An important trend worth noting is the increasing focus on end-of-life battery recycling. The growth of electric vehicles could leave us with a lot of batteries to recycle in the coming years. It is estimated that globally there would be 11 million tons of Li-Ion batteries to be recycled by 2030. Regulations have been introduced in European Union, which make battery recycling a high priority by requiring battery manufacturers to finance the costs of collecting, treating and recycling batteries. As of right now, only 5% of the total batteries are being recycled in EU. There are multiple ways recycled batteries can be repurposed. In some cases, sweltering is carried out to recover precious metals including Cobalt and Nickel, and further processing is done to recover Lithium. In other cases, batteries are refurbished/remanufactured after use in one application to be reused in other applications. For example, according to the EV industry, the “degraded” battery from the car is still at ~80% of its capacity. These batteries can be used directly with minimum processing in other applications for home energy storage or UPS. Nissan has already partnered with Eaton to reuse their car batteries for home energy storage applications.

**Who is leading the R&D? (Learnings for Grid Sector):**
The major portion (90%) of R&D expenditure in the battery market is being driven by the towards electric vehicles. Characterized as a fast-moving industry with re-design cycles of 4 to 5 years, automotive tends to use latest and greatest with a focus on reduced cost. In this case, as most of the batteries are being manufactured externally, battery manufacturers are spending significant money on R&D to develop and improve the technology further. These advances can also be utilized by other end-applications by working with these battery manufacturers.

**From Garage to the Grid**
As an example, the power grid industry can capitalize on advances in the automotive sector to their benefit, or as we describe it, from the garage to the grid. Companies working in the grid sector need to collaborate more with the automotive industry to utilize battery technology for the grid. Especially with increasing e-mobility, the overlap between grid and automotive sectors is increasing. More and more pilots of V2G based solutions are being installed focusing on applications like frequency regulation and peak shaving e.g. Oxygen Initiative in California and the Tennet-Vandebron partnership in the Netherlands.

Table 1 shows comparison of battery
requirements of the grid sector vs automotive. In almost all cases, automotive has stricter requirements than grid to be fulfilled. This is an indication that the same technology can be used in the grid sector, avoiding billions in R&D costs working from scratch. In some cases, this collaboration is already happening. Tesla EV also supplies its Powerwall for energy storage. In the future, there is potential of more automotive OEMs offering similar solutions or partnering with grid focused companies to provide solutions for alternative markets. We believe in the end, market winners would be those with maximum collaboration and multiple partnerships, and not just the ones with the best technology.

**Battery Market Supply Demand: Capacity utilization:**
Despite the increasing demand for batteries, utilization of battery cell manufacturing capacity is relatively low. Globally, these manufacturing plants are running at 60-70% utilization. This is expected to become better in the future given increased demand of EVs and grid storage. However, considering multiple new giga factories being announced, maximum utilization is expected to still stay below 80% as shown in figure 2.

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<tr>
<th>KPI</th>
<th>Grid</th>
<th>Automotive</th>
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<tr>
<td>Energy Density (Wh/L)</td>
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<td>Power Density (W/L)</td>
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<td>C-Rate</td>
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<td>Depth of Discharge</td>
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<td>Operational temperatures</td>
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<td>Cost Affordability</td>
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**Supplier Market Shares:**
From a supply point of view, Asian manufacturers are dominating with LG Chem (South Korea), Panasonic (Japan), Samsung SDI (South Korea), AESC (Japan), BYD (China) and CATL (China) having around two thirds of the market share. However, there is an increasing push to locate battery manufacturing in Europe to reduce reliance on Asian manufacturers. Companies like BMZ group in Germany and Northvolt in Sweden are setting up new or expanding existing manufacturing facilities to meet the growing demand of Li-Ion storage solutions in Europe. The graph below represents the market share of various manufacturers in 2017:

![Supplier Market Shares - 2018](image)

*About our [EV Battery Supplier Research]*
Industrial Motors Market Overview

By Jared Kearby

2018 Global Market: $25.5B

Americas
Commercial HVAC, Oil & Gas
30%
$7.65B

EMEA
Chemicals, Data Centers
29%
$7.39B

APAC
Mining & Metals
41%
$10.46B

LV Motors
5.5% Growth in 2019
$20.1B

MV Motors
4.5% Growth in 2019
$5.4B

Supply Chain Highlights 2019

1. Raw Materials
   Trade tension and tariffs will cause increase in prices.

2. Component Supplier
   Strive to keep profit margins due to higher material costs.

3. Manufacturer
   Sales to EPCs increase due to heavy-industry projects.

4. Sales Channel
   LV sales via distribution will outpace integrators and machine builders.

5. End-User
   Energy efficiency is not top priority for most end-users; IE3/4 motor adoption remains mild.

About our Industrial Motors Market Research
Technology Overview:
IEC61850 in Digital Substations

By Saqib Saeed
A Substation (SS) acts as a strategic node in a transmission and distribution (T&D) network. Most substations operating at high voltage (HV) or extra-high voltage (EHV) perform switching and routing of AC power. So, the operation of substation equipment which is aimed at the routing/switching of power (operation of switchgear etc.) is termed as the “primary process”. A substation is called digital in which the data related to protection, control and monitoring of the primary processes is digitized immediately after the measurement. Technically, digital substation refers to a substation that employs both IEC 61850 Process Bus and Station Bus in its protection and control architecture. Before going into the details of digital substations, it is crucial to summarize the governing communication standard of digital substations, IEC 61850.

What is IEC 61850?

With the introduction of powerful micro-processing tools and multi-functional relays (known as Intelligent Electronic Devices or IEDs), the power systems industry entered the digital age. Initially, the use of communication technologies in a substation was limited to offline data collection only. However, the advancements in communication IEDs has enabled utilities to perform real-time control and protection operation. In the early 90s, various manufacturers introduced communicable IEDs, however a lack of common communication protocol resulted in a chaotic situation. As a result, utilities ended up spending huge amounts of money on device integration from different manufacturers. At that time, international organizations started looking into the possibility of standardizing the communication protocol for power systems industry. In 1997, both IEC and IEEE partnered together to develop a common standard for substation communication which is now popularly known as IEC61850. Naturally, the standardization process involved all the major stakeholders including system manufacturers and key utilities.

Traditionally, process equipment was connected with bay level devices through copper wiring. With the introduction of IEC 61850 process bus, the process equipment is connected with the rest of the system (IEDs) through a digital interface. Two crucial parts of IEC 61850 series of standards, IEC 61850-8-1 and IEC 61850-9-2 are defined as Generic Object-Oriented System Event (GOOSE) and Sampled Measured Values (SMVs).

1- Sampled Measured Values (SMVs):

Analog signals (waveforms) from sensing equipment (instrument transformers) are converted into a stream of sampled values. SMVs are broadcasted over the communication network and can be accessed by any IED which needs the information. Sampled values are time stamped so that the receiver can correlate the samples coming from different sources.

2- Generic Object-Oriented System Event (GOOSE):

GOOSE messages contain information in the form of a dataset which contains status indication in binary form. Just like SMVs, GOOSE messages are also available for any IED connected to the system. A typical example of GOOSE dataset would be the status indication of all the switches in one bay to all the other bays level devices in the substation. Information packed in one single dataset and broadcasted over the communication network means removal of several hardwire connection which existed in traditional substation design (one network cable replacing several hundred meters of copper wiring).

Hardware for a Digital SS

A standardized communication mechanism laid a great foundation for digitally enabled substations. Additionally, evolution of
hardware equipment, especially sensing and measurement equipment, has revolutionized the field of digital SS as well. The most crucial enablers of digital substations are the non-conventional Instrument Transformers (NCITs) and standalone merging units (MUs) which utilize IEC 61850 process bus communication.

**Non-Conventional Instrument Transformers (NCIT):**
At its core (pun intended), the working principal of a traditional instrument transformer (current [CT] & voltage [VT] transformer) is based on ferromagnetic circuit tightly coupling primary and secondary coils. So, much like power transformers, conventional instrument transformers also transfer power from its primary to secondary. NCITs on the other hand have a very low energy output (typically do not transfer power to the secondary) which eradicates the risks typically linked with a conventional instrument transformer including open (short) secondary in CT (VT), saturation and non-linearity. Additionally, the inherent signal processing nature of NCITs removes the need for the analog-to-digital conversion which makes them a perfect building-block for a digital substation. These are the different technologies used in NCITs:

- Fiber Optical Current sensor (FOCS)
- Rogowski Coil CT
- Electronic Voltage Transformer

**Merging Unit (MU):**
Merging unit is defined in IEC 60044 and its functions include simultaneous sampling and relaying of current and voltage measurements. It converts the analog signals from CT and VT into IEC 61850 SMVs. Merging unit itself does not include any protection functionality but it acts as an interface for the primary process equipment.
Benefits of a digital substation
In order to make a measurable impact in the market, any new technology must be able to present tangible benefits not only in terms of cost but also in performance over the existing technology. Additionally, for power grid, reliability and security also play an extremely crucial role in the adoption of a technology. Here are some of the benefits presented by IEC 61850 process bus based digital substations over conventional substations.

Design Simplicity and Flexibility:
As described earlier, in the traditional substation design several point-to-point copper wire connections exist from the switchyard to the bay level protection and control devices. Due to the hardwired connections, output from an instrument transformer cannot be shared with several bay level devices. In case of process bus, any IED at bay level can speak with any process level device. Figure 1 and figure 2 depict (in a simplified form) the difference between a conventional and a digital substation.

Cost Saving:
Implementation of process bus in a substation can reduce the total cost of installation which include engineering, drafting, construction and commissioning. Complex copper wiring is a big contributor to the engineering cost of a substation design.

Protection Scheme enhancements:
As already explained, the flexibility achieved through IEC 61850 process bus in terms of information exchange plays a crucial role in providing enhanced protection coordination among the bay level IEDs. Trip, blocking, status or any logical signals are transferred through the same network using GOOSE, and can support peer-to-peer applications in a substation. In addition to that, reference presents other opportunities, such as failure of any current transformer or an MU can be easily compensated by estimating lost signal from other MUs, and installing centralized back-up protection system instead of providing individual duplication.
Interoperability:
Different manufacturers can provide full integration of protection functions on all bay level IEDs. A simplified representation of interoperability is shown in the figure below showing how IEDs from various manufacturers can interact with each other in a substation environment.

Conclusion:
IEC 61850 revolutionized substation automation enabling utilities to implement a cost effective ‘copper-less’ (reduced capital cost) solution while creating an interoperable (reduced O&M cost) communication network throughout their substations. More utilities around the globe have tendency to incorporate IEC 61850 process bus enabled digital substations in their network. Process Bus technology offers a variety of new and exciting possibilities in designing the next generation of Ethernet-based protection and control systems.

About our Substation Equipment Market Research
EV Traction Motors Market Overview

By Jared Kearby

Global Market 2.46 Million Units

Supply Chain Highlights 2019

1. Raw Materials
Trade wars between US and China could cause volatility in rare earth material supply.

2. Comp. Supplier
High EV demand will drive growth for all EV component suppliers.

3. Manufacturer
Increased collaboration & acquisitions within the traction motor sector is expected.

4. Sub-Assembler
Traditional automotive OEMs will look to third-party assemblers to begin production planning rather than invest internally.

5. Electric Vehicle OEM
Increased competition from traditional automotive OEMs as well as newer market players.

About our Traction Motors Market Research
Conferences & Trade Fairs

PTR will be attending following trade fairs in the coming months:

- CWIEME Berlin
- pcim Europe Power Electronics
- Inter Solar Europe

PTR’s co-founders Saqib Saeed and Jared Kearby will be hosting various panels and presenting on power transformers and motors at CWIEME Berlin:

- Presentation on Transformers
- Presentation on EV Chargers
- Panel on Industrial Motors
- Panel on EV Traction Motors

If any of these topics is of interest, please reach out to one of PTR colleagues, and they will gladly share these presentations with you.

Our Recently Launched/Updated Services

The following services have been launched/updated and are available off-the-shelf:

**E-Mobility Services Ecosystem Players – Monthly Trackers**

Within PTR’s e-Mobility segment, these new trackers are meant to give an overview of the market positioning of E-mobility service providers, charge point operators, and hardware & software suppliers operating in the e-mobility charging ecosystem. Three trackers cover Technology Providers, Service Providers and New Age Utilities operating in e-mobility space.

[Click here for more details](#)

**EVSE – Charging Infrastructure**

In this service, PTR covers EV charging infrastructure market in 39 countries in all major regions around the globe. Market growth outlook for all charging power capacities (kW) is being tracked in this coverage. Output also includes market size by Charging Type (ChaDeMo, CCS, Tesla SC) and further customization is possible to separate AC/DC charging stations. Along with the market sizing, analysis of charging OEMs, value chain and competitive analysis are also included for North America, Europe and APAC.

[Click here for more details](#)
Our Services
Consulting & Off-the-Shelf

Power Grid

- Transformers Market Assessment
- HV/MV Switchgear Coverage
- HVDC Project Database
- FACTS Projects Database

E-Mobility

- EVSE – Charging Infrastructure
- E-Mobility Services Ecosystem
- Commercial & Off-Highway Vehicles
- EV Traction Motors
- Battery Supplier Benchmark
- EV Impact Report

Generation

- Generation Projects Database
- Solar Cost Models
- Solar Benchmarking Analysis