



Market Report Electrical Engineering 2020/21

A global outlook for the transformers, industrial motors, EV traction motors, EV hybridisation and coil winding machines markets.

A white paper in partnership with



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May 2020 | CWIEME Intelligence Series

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Definitions and Acronyms

UNIDO	United Nations Industrial Development Organization
IEA	International Energy Agency
EV	Electric Vehicle
OEM	Original Equipment Manufacturer
AC/DC	Alternating Current/Direct Current
HVAC	Heating, Ventilation, and Air Conditioning
HP	Horsepower
VFD	Variable Frequency Drive
PHEV	Plug-in Hybrid Electric Vehicle
BEV	Battery Electric Vehicle
ACIM	AC Induction Motor
PMSM	Permanent Magnet Synchronous Motor
HTM	Hybrid Traction Motor
SRM	Switched Reluctance Motor
NMC	Nickel Manganese Cobalt
SGCC	State Grid Corporation of China
CSG	China Southern Grid
T&D	Transmission and Distribution
HVDC	High Voltage Direct Current
IoE	Internet of Energy
PTR	Power Technology Research

EXECUTIVE **SUMMARY**

The US-China trade wars and Brexit were not only news headlines, but steered the direction of monetary flow for the whole world in an unexpected direction. Washington planned to handcuff Beijing by imposing the tariffs over the Chinese products worth more than \$250 billion and Beijing reciprocated by imposing tariffs on American products worth more than \$110 billion. As a result of these events, 2019 shows a negative trend in overall manufacturing production in every quarter. According to United Nations Industrial Development Organization (UNIDO), the fourth quarter of 2019 showed a consistent decline and fell below 1% to rest on 0.7%. Industrialised economies such as Germany, Japan and United States have seen some major contractions in their manufacturing growth during 2019. Key reasons were the trade tensions between China, United States and Europe. Weaker external demand for European goods and higher oil prices were the main causes of damped growth in Europe.

Going into 2020, the economic slowdown from the previous year was expected to continue with some positive developments projected towards end of the year. However, the ongoing COVID-19 pandemic has completely changed the outlook and resulted in tremendous uncertainty regarding the global growth forecast. Last month, the IMF revised down its output projections due to COVID-19 in its April economic update. They pointed out that, unlike in the global financial crisis, governments are unable to encourage economic activity by stimulating aggregate demand due to contamination risk. They claimed this will be the worst crisis since the Great Depression, contracting the global economy by 3 per cent this year with many western markets 2-3 times worse than that. Whether or not this forecast comes to fruition depends on the ability of governments to a) "flatten the curve", allowing their healthcare systems to not be overwhelmed followed by b) restart their economies in a structured way.

Many governments have already started to open up again with many more expected to do so throughout May and June. Limitations will remain in place, thus prolonging economic impacts to many industry sectors. It is no surprise that specific industries such as travel, hospitality, entertainment, and tourism have been hit the hardest by COVID-19. This has been closely followed by the mobility sector, represented largely by automotive, and certain forms of energy such as oil & gas.

Market Snapshots

Transformers

The global power transformers market reached \$17 billion in 2019. EU-28 power transformers market, driven by renewable new additions and grid expansions, reached \$ 1 billion in 2019. In non-conventional transformers category, the converter transformers market is growing at a rapid pace. PTR expects that the global converter transformers market will reach \$5.3 billion by 2025. Cross-border interconnections in Europe and bulk power transfer projects in Asia are two key driving forces for converter transformers market. Additionally, the distribution transformers market reached \$9 billion in 2019 with highest market share held by APAC.

EV Traction Motors

From 2016 to 2025, EV shipments are expected to increase by a 35% average annual growth rate, according to IEA. This presents a growth opportunity for the manufacturers of the core components for the EV drivetrain: traction motors and batteries. Benefiting from passenger EV incentive programmes in countries such as China and the United States, the global passenger EV market grew by 15% to 2.8 million units in 2019. This growth is not expected to slow down in the next few years and will drive demand for all components of the electric vehicle, including the traction motor.

Industrial Motors

The sales of industrial motors is an indicator of demand for motor manufacturing machinery, such as coil winding and forming machines. In 2019, the industrial motor market, in terms of revenue, was valued at \$25.7 billion. Despite political uncertainties and due to up-swings in previously stagnant sectors, the low- and medium-voltage motor market was expected to see modest growth in 2020 prior to the start of the COVID-19 pandemic. As a result, the sales of LV and MV motors will decline because of reduced demand, factory shutdowns, and supply chain bottlenecks. In the long-term the market will recover the losses due to increased investment in factory automation driven by the impacts from COVID-19.

Coil Winding Machines

The global coil winding machines market is expected to grow with a modest growth worldwide. The ever increasing dependence on electrical equipment has brightened the chances for this market. OEMs will have significant opportunities in this market as it is expected to expand in Japan, China and Americas.

TRANSFORMERS

The global Transmission and Distribution (T&D) equipment market is driven by fast-paced electrification in developing markets and infrastructure replacements in established markets like Europe and North America. Advancements in grid edge technologies, electric vehicles and distributed energy resource management systems have been the key milestones of the last five years. However, the legacy grid equipment (such as transformers and switchgear) is still one of the key drivers of total T&D spend across the globe. For example, in the United States, transformers roughly account for 16% of the total T&D spend.

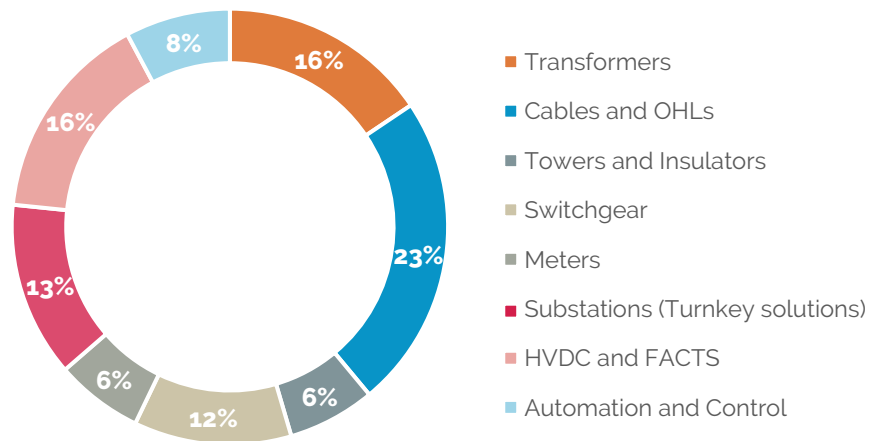


Figure 1 Segmentation of T&D spend in the United States

Source: Power Technology Research

Power Transformers

The global power transformers (>72 kV) market reached 17.2 billion USD in 2019 with major revenue coming from the APAC market. In Europe, Germany, France and the UK have the highest share of T&D spend in the region, including transformers. The total power transformers market in Germany was higher than 200 million USD in 2019 and the market is primarily driven by renewable additions in the network. In North America, the United States power transformers market reached to a total of 3 billion USD which is driven by a mix of new additions and replacements.

In addition to conventional power transformers, the High Voltage Direct Current (HVDC) converter transformers market is also rising with long distance HVDC interconnections around the globe. According to PTR, the converter transformers market is expected to reach 5.3 billion USD by 2025, providing excellent prospects for conventional transformer suppliers operating in Europe and Asia. The HVDC converter transformers market is primarily driven by offshore wind, long distance bulk power transfer and cross-border interconnections.

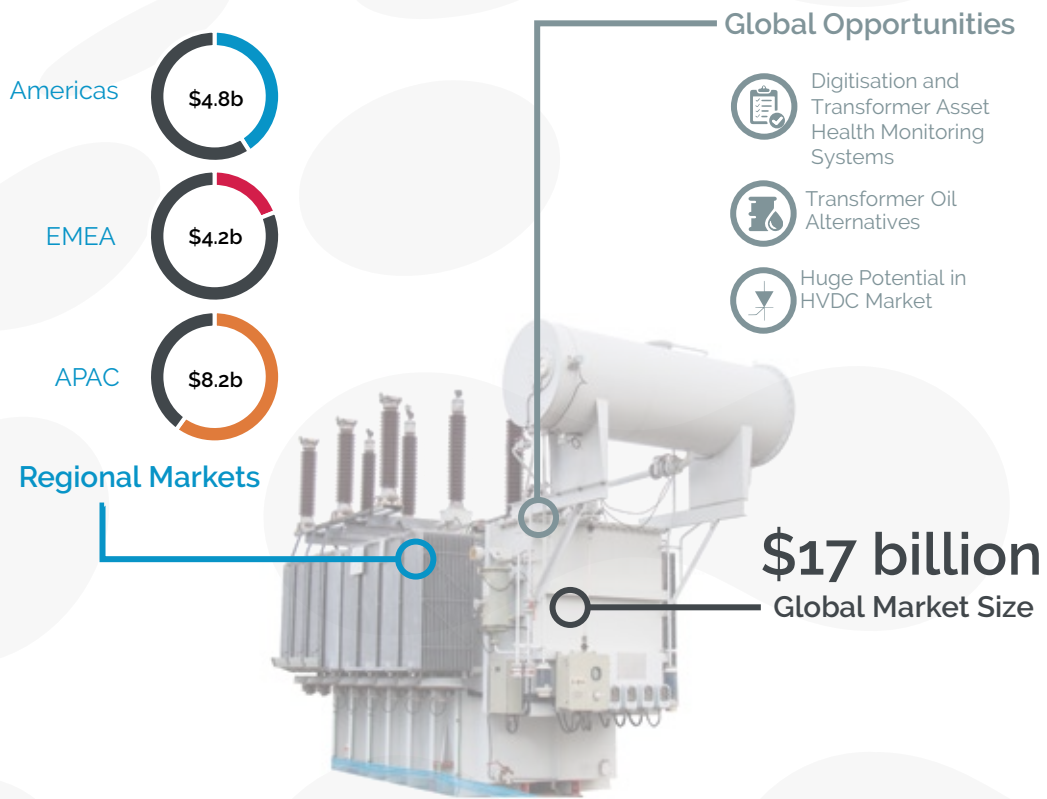


Figure 2 Global Power Transformers Market
Source: Power Technology Research

Distribution Transformers

The global distribution transformers (<72kV) market was valued at 9.2 billion USD in 2019 with major revenue coming from APAC and Americas regions. China and India were the biggest markets of distribution transformers in the region. The distribution transformers market is driven by distribution network expansions and massive replacement drives of distribution transformers in countries like India and China. In terms of technology adoption, there has been an increasing trend of dry type transformers due to the higher penetration of renewables (especially in wind power applications).

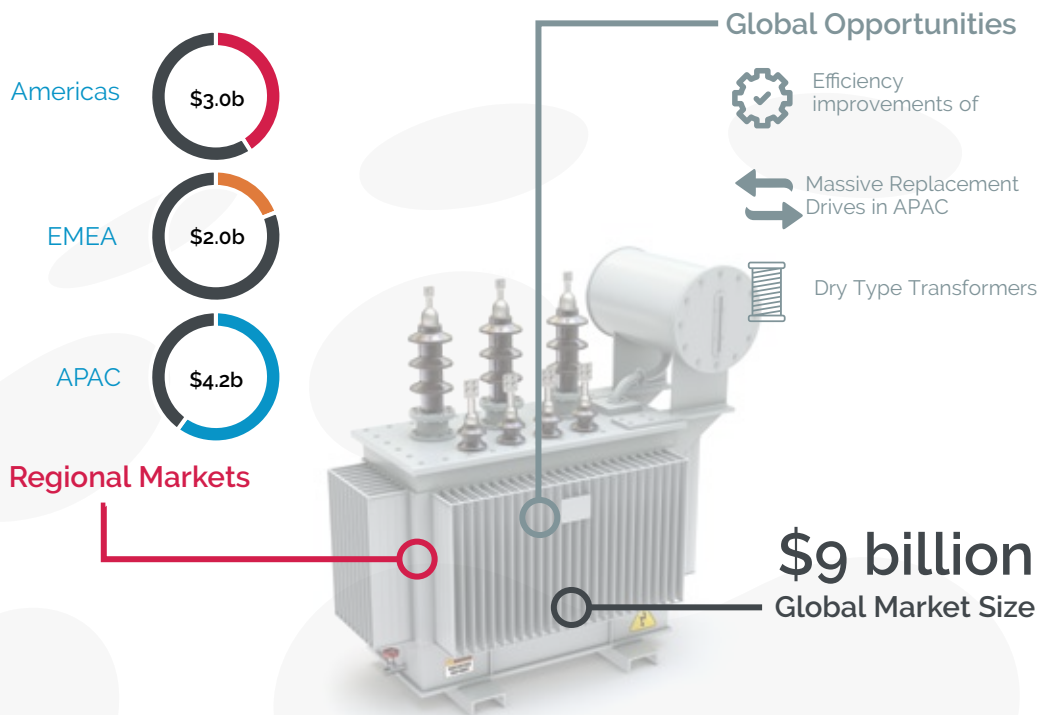


Figure 3 Distribution Transformers Market
Source: Power Technology Research

Digitalisation & Renewable Integration

The generation mix is slowly tipping towards renewable energy sources on global scale. Governments around the world have set aggressive goals of installing wind and solar to reduce dependency on fossil fuel power plants.

This paradigm shift has opened gateways for the transformer industry as well. Technological advances in transformers are helping to increase the efficiency of integrated grid and renewables networks, simplifying renewable integration and helping to optimise voltage control during the transmission and distribution of energy generated from clean resources. The APAC region is expected to flourish its renewable side thus leaving great margins for smart and efficient transformers to be incorporated. Manufacturers are keenly viewing this market as a key opportunity of major future investment.

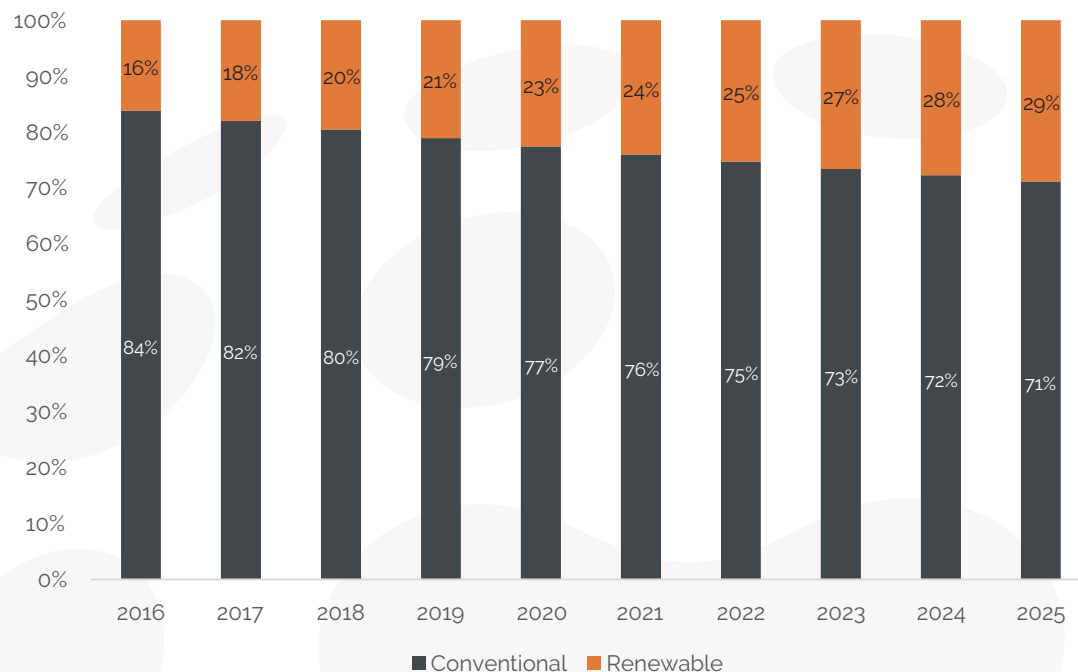


Figure 4 Global Generation Mix (Conventional vs Renewable)

Source: Power Technology Research

Digitalisation, on the other hand, is the new focus of power and grid systems. Suppliers have introduced diagnostic systems for some of the most critical components including transformers, both power and distribution, which are able to predict faults and hence maintenance in time before the fault occurs leading to high reliability.

Transformers with these in-built systems are being referred to as digital transformers. Digital transformers are expected to have overall lower life-cycle cost as these transformers are easier to maintain and have lower failure rates. Hence, these are becoming an ideal choice for critical applications. Most suppliers, including ABB, Siemens and GE are offering digital transformers and are in fact actively trying to bring this solution to more and more industrial customers.

Online monitoring systems are very popular in both Europe and America for power transformers. In the MEA region, Saudi Arabia is the only country which is very critical about online monitoring systems for power transformers. In the APAC region, except for China, digitalisation in the T&D sector is not a crucial parameter right now. However, as an emerging economy, India is seriously thinking about smart operations of grids and transformers. South America is also considered as a hub of future digitalisation by foreign companies. Brazil, for instance is becoming a strong market for smart grid investment with the privatisation of electrical utilities.

2020 Outlook

There is a severe ambiguity around the global growth forecast due to the COVID-19 pandemic. The economic implications of this pandemic are dependent on several intertwined factors making it difficult to predict the economic fallout. PTR expects that the COVID-19 situation will impact the supply chain of transformers, especially the raw materials pricing and capacity utilisation of manufacturing facilities. With an assumption that most of the countries will lift lockdown and travel restrictions within Q2, PTR expects that the distribution transformers market will quickly bounce back by the end of Q3. On the other hand, the power transformers market might be impacted beyond Q3 as the timelines of large T&D projects will be reevaluated. Additionally, some major T&D projects might be delayed due to reassignment of funds to other priority sectors such as healthcare by some countries.

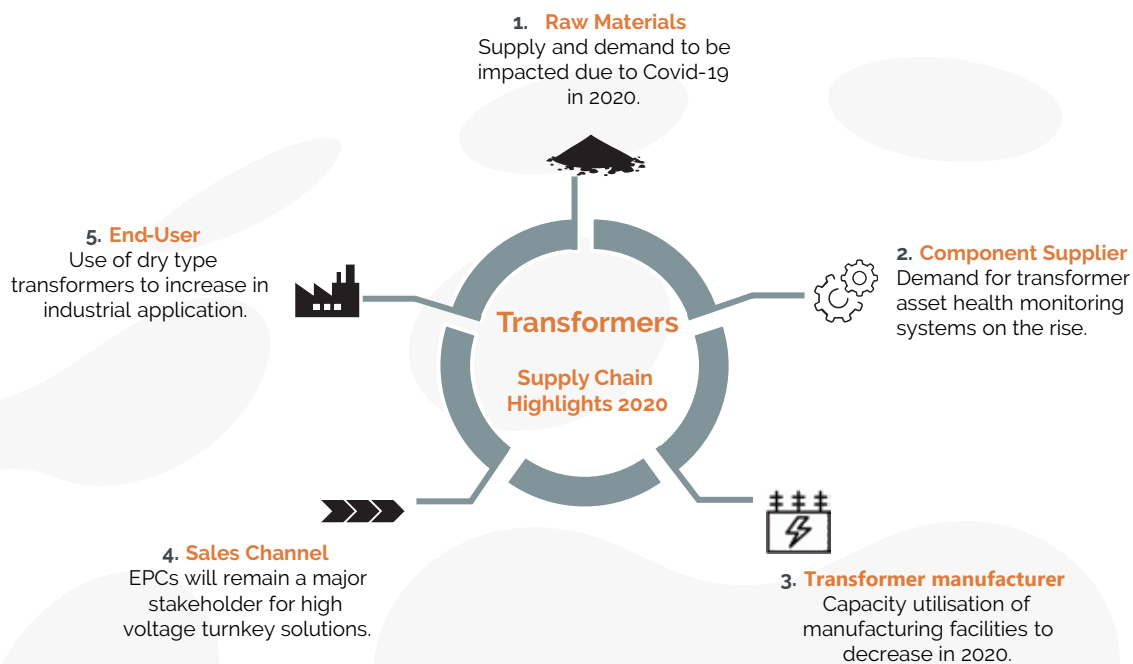


Figure 5 Transformers Supply Chain Highlights (2020)

Source: Power Technology Research

INDUSTRIAL MOTORS

In 2019, the industrial motor market amounted to over 25.7 billion USD in revenue. Of that, 79% is attributed to low-voltage products, including servo, integral HP, and DC motors, while the other 21% is attributed to medium-voltage motors. Year over year, 2019 remained relatively flat with a less than 1% annual growth rate compared to 2018 due primarily to the economic slowdown in Asia Pacific and Europe.

2019 is considered to have been a 'balancing year' due to the relatively strong growth rates in 2017 and 2018, which reached near 5% annual growth rates each year. Reduced automotive and consumer demand in Asia Pacific while overstocked inventories and fewer capital equipment investments in Europe resulted in a lower growth rate for industrial motors globally. The Americas market was pillared by investments within process sectors in the first half of 2019, such as oil & gas, chemicals and mining & metals.

The APAC region accounted for the largest portion of the market with 41%; China accounted for 21% alone. The Americas totaled 30% of revenue; with the United States accounting for almost 20%. The EMEA region equaled 29% of the global market and the largest market within that region, Germany, totaled 8% of revenue in 2019.

Global Market \$25.7b

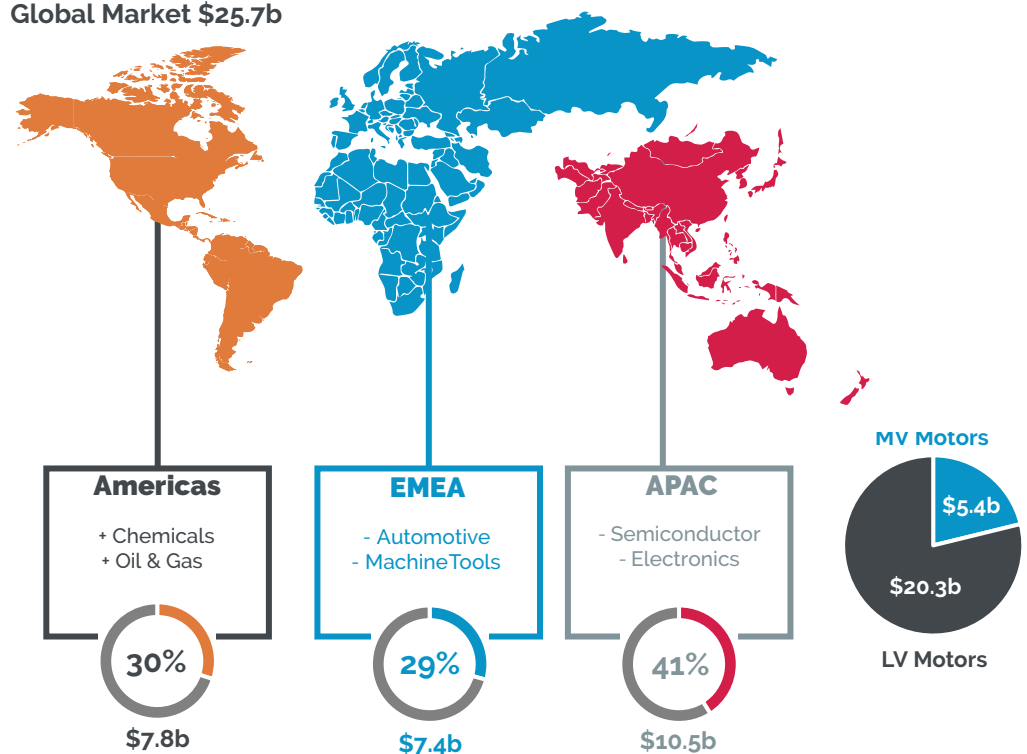


Figure 6 Industrial Motors Market

Source: Power Technology Research

Key Trends

According to World Energy Outlook (IEA), more than 70% of the industrial sector and more than 53% of the domestic sector use motors in one form or another (see Figure 2).

Due to the increasing adoption of automation, improving the efficiency of electric motors and consequently reducing their carbon footprints has been a key focus for regulators.

MOTORS ACCOUNT FOR MORE THAN HALF OF TODAY'S ELECTRICITY CONSUMPTION

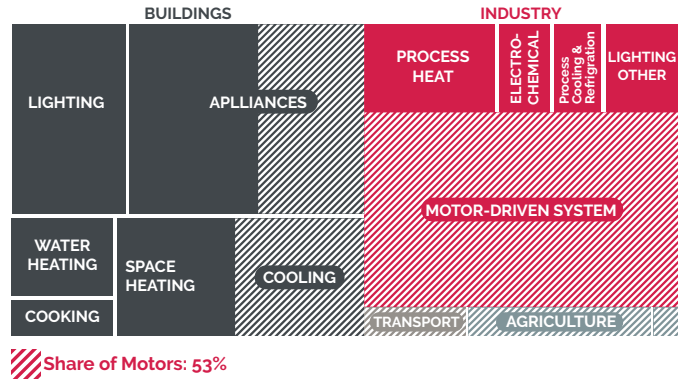


Figure 7 Electricity Consumption of Electric Motors
Source: IEA

Efficiency Improvements

Developed and developing countries are on the same battleground of global warming and CO₂ emissions. Therefore, countries are now opting for stricter policies and standards through which CO₂ emissions can be minimised systematically. The motors market is estimated to consume 10,700 TWh per year, according to IEA. As a result, a small efficiency improvement brings significant energy savings and consequently reduces the carbon footprint of industrial motors. Policymakers around the globe are now adopting and exploring new ways to stimulate the wave of energy-efficient motors in their respective countries. Advanced international standards, governmental incentives and consumer awareness are key parameters that will pave the way for change.

With different countries enforcing higher efficiency standards throughout the decade, the share of premium and high efficiency motors has increased multiple folds compared to its market share at the start of the decade. Figure 4 and 5 depict a competitive view of IE1, IE2 and IE3 motors at the beginning and end of the decade respectively. The share of IE1 motors reduced from 69% at the start of the decade to only 22% in 2019. Consequently, IE2 and IE3 motors hold a much higher share in the global market.

Industrial Motors Split by Efficiency Classes (2010)

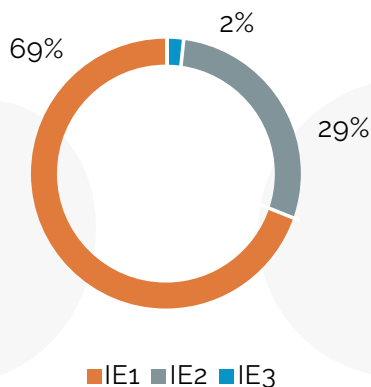


Figure 8 Industrial Motors Market - 2010
Source: Power Technology Research

Industrial Motors Split by Efficiency Classes (2019)

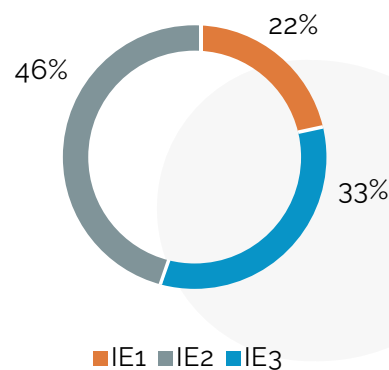


Figure 9 Industrial Motors Market - 2019
Source: Power Technology Research

Variable Speed Drives

In addition to the continues push for higher efficiency class motors, the variable speed drive (VSD) market is another important topic in the industrial motors ecosystem. The VSD market gained momentum in 2019 as retrofitted VFDs on IE2 motors continued to be an alternative to IE3 and IE4 motors.

This trend is seen globally, but most predominantly in EMEA as it is the global leader in implementing efficiency standards. Although the last phase of the 2009 directive was in 2017, the residual impacts are still being seen within the drives market today. With the recent Commission Regulation (EU) 2019/1781 initiated in October 2019, the next phase of the energy directive in the European Union will go into effect July 2021. This will have widespread implications as the pairing of an IE2 motor with a VSD to meet the efficiency standard will no longer be applicable. In addition, variable speed drives will also need to adhere to efficiency standards. Since Europe is typically the first to adopt new efficiency standards for electric motors, it is likely this is an indication of changes to come for the other regions as well.

2020 Outlook

PTR anticipates negative growth in 2020 for the industrial motors market as a consequence of the COVID-19 situation which will impact both the supply and demand sides. Indications in early Q1 pointed to a slight recovery in manufacturing production but the recent developments have placed the recovery on hold - at least for now. PTR expects a market decline in the range of 10-20% depending on which of our scenario occurs. Despite all the pessimism surrounding the 2020 outlook, PTR sees a glimmer of positivity for the future of industrial motors.

Although industrial production will be negatively impacted in the short- and medium-term, PTR believes there will be long-term benefits to the situation for the industrial machinery market. To prevent further production bottlenecks in the future, machine builders and OEMs will invest more in increasing the automation levels of their machinery. This will allow fewer personnel to operate and monitor the machinery locally and enable increased remote monitoring, management and operating. While the system will not be fully autonomous and will still require local personnel, this will allow for the operators to mitigate their risk in situations like this and maintain at least minimum levels of production.

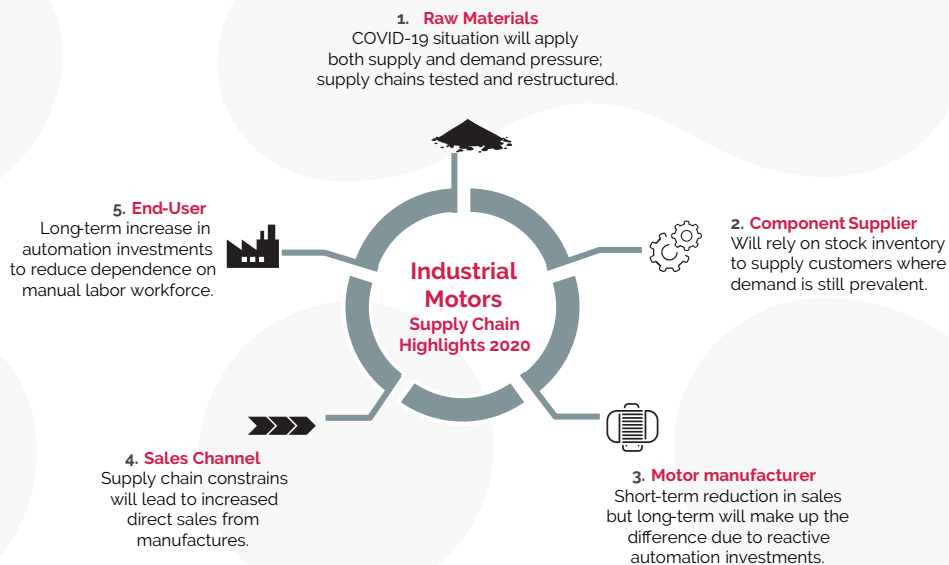


Figure 10 Industrial Motors Supply Chain Highlights (2020)

EV TRACTION MOTORS

From 2016 to 2025, EV shipments are expected to increase by a 35% average annual growth rate, according to IEA. Bloomberg New Energy Finance (BNEF) in its "Global EV outlook 2019" predict an optimistic outlook for EV's share in future. They expect that by mid-2020 the price difference between ICE based vehicles and EVs will be negligible. By 2030, it expects ICE vehicle to peak before its decline will start. By 2040, 57% of all vehicle sales and 30% of passenger vehicle sales will be electric.

In 2019, the global passenger Plug-in Hybrid Electric Vehicle (PHEV) and Battery Electric Vehicle (BEV) traction motor market is totaled 2.8 million in terms of units shipped – an increase of over 14% compared to 2018 levels. Within this market, the three prominent traction motor technologies are AC Induction Motors (ACIM), Permanent Magnet Synchronous Motors (PMSM), and Hybrid Traction Motors (HTM); the last of which use a hybridisation of permanent magnets and reluctance technology. Of the combined traction motor market for passenger BEVs and PHEVs in 2019, PMSM, HTM, and ACIM accounted for 79%, 17%, and 4%, respectively. From 2018 levels, the HTM motor market gained 1% share while PMSM remained flat and ACIM motors lost 1% of market share year over year.

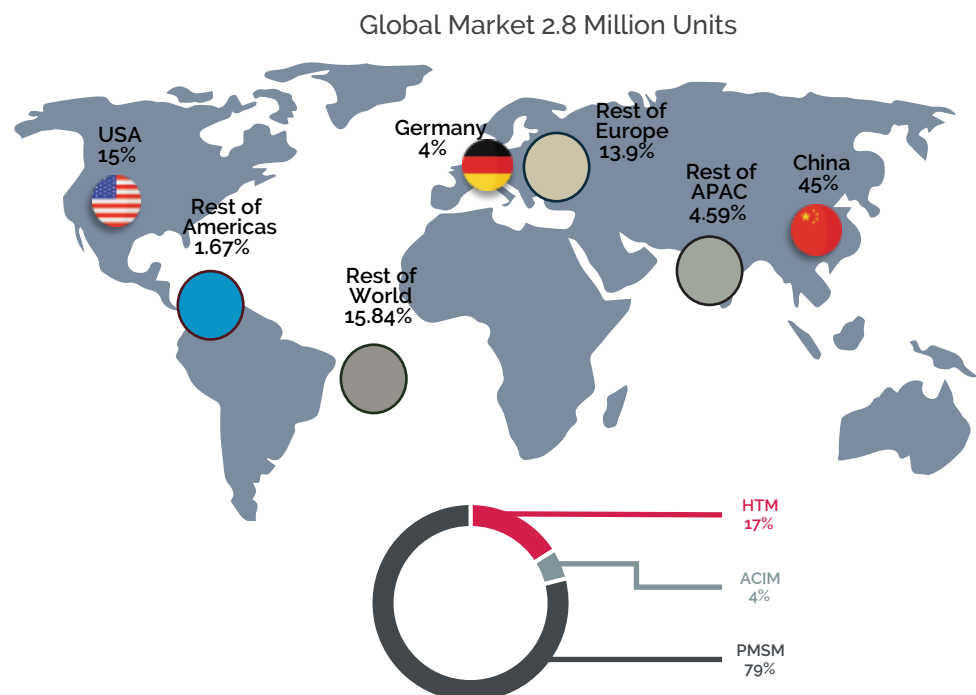


Figure 11 EV Traction Motors Market 2019

Source: Power Technology Research

Competing Technologies in EV Traction Motors

The EV traction motor market is often overshadowed by the other systems of the electric vehicle, such as the battery and charging infrastructure. This is because it is viewed as already having the required technology for the future growth of EVs since it utilises motor technologies that have been around for decades with proven application in several sectors. However, PTR believes there is potential for a technology disruption within the EV traction motor market as alternative motor technologies and architectures may become widely adopted.

In addition to HTM technologies, there is a significant amount of investment flowing into Switched Reluctance Motors (SRM) technology, spawned by the increase of rare-earth material costs from China in 2011 and again in 2017. Due to the advancements in resistor and control technologies, these products are now becoming feasible for passenger EV applications.

If high volume production can be achieved at competitive costs for use in passenger EV fleets, PTR estimates that SRMs will be first installed into mass-produced EVs by 2025. Until then, the market will remain dominated by PMSM and AC Induction motors.

PTR believes that the investments into alternative motor technologies that use either significantly reduced or zero permanent magnet materials will cause the rare-earth materials supply volatility from China to become a non-issue. With the bulk of R&D investment for traction motor technology occurring in the Europe, this shift will first happen in the EMEA region, followed by the Americas region. Traditional PM motors will remain dominant in Asia as it benefits from locally sourced rare-earth materials.

EV Hybridisation & 48V System

The 48V mild hybrid electrification system is an extremely attractive value proposition for the automotive industry at the moment. 48V mild hybrid vehicles reduce CO₂ emissions by 13-21%. The biggest advantages of the 48V technology are a relatively simple integration in the existing vehicle architectures and the high efficiency of the components. Coupling hub motors with the 48V battery systems are opening new dimension for R&D in the e-mobility market. Together they are expected to provide extremely efficient and reliable technical advancement in the field of EVs. Mild hybrids cannot reach the CO₂ reduction and fuel economy levels of plug-in hybrids, but they are not dependent on user behaviour to provide the benefits. There are several mild hybrid models on the market. With almost no presence a couple of years ago, mild hybrids are now considered as an essential tool to achieve 2025 emission milestones. PTR believes that 48V systems will have a significant share in the EV market by 2025 with Europe leading the adoption race.

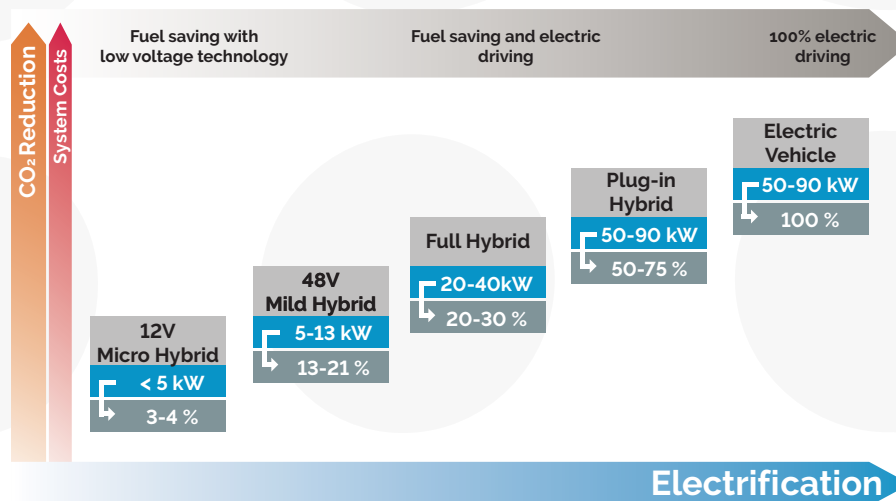


Figure 12 EV Hybridisation
Source: Continental Corp.

BEVs and Storage

Major BEV manufacturers have launched their new generation BEVs by extending the drive range. This plan has triggered battery OEMs which have launched new developed batteries to fulfill these criteria. Optimised lithium-ion cells, better cooling strategies, advanced battery management systems are some examples.

As per PTR research, innovative ideas like lithium-air, complex solid-state technology, and alternative metal-ion chemistries will trigger a new era in this field.

This will force the EV manufacturers to invest in these new technologies if they want to retain their position in the booming EV market.

In addition to that, manufacturers are also betting on electric mobility to grow at a very high rate globally. Many manufacturers have invested heavily in anticipation of increasing demand to expand their production capacity. This has led to an overcapacity in the market right now, which is expected to stay for the next five years, albeit decreasing slowly.

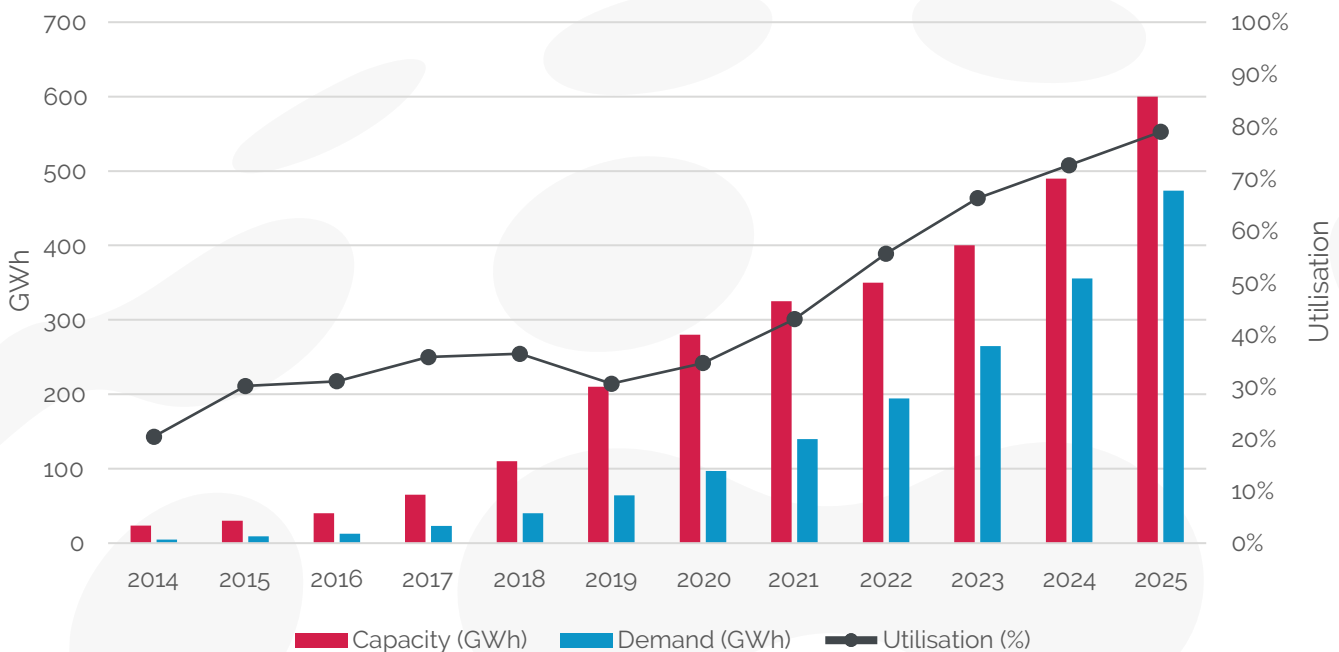


Figure 13 Battery Cell Supply/Demand Forecast

Source: Power Technology Research

PTR believes that other industries can take advantage of the current situation, and leverage both the advancements in automotive battery and the overcapacity in the market. As an example, the power grid industry can capitalise on advances in the automotive sector to their benefit. Especially with e-mobility increasing, the overlap between grid and automotive sectors is increasing.

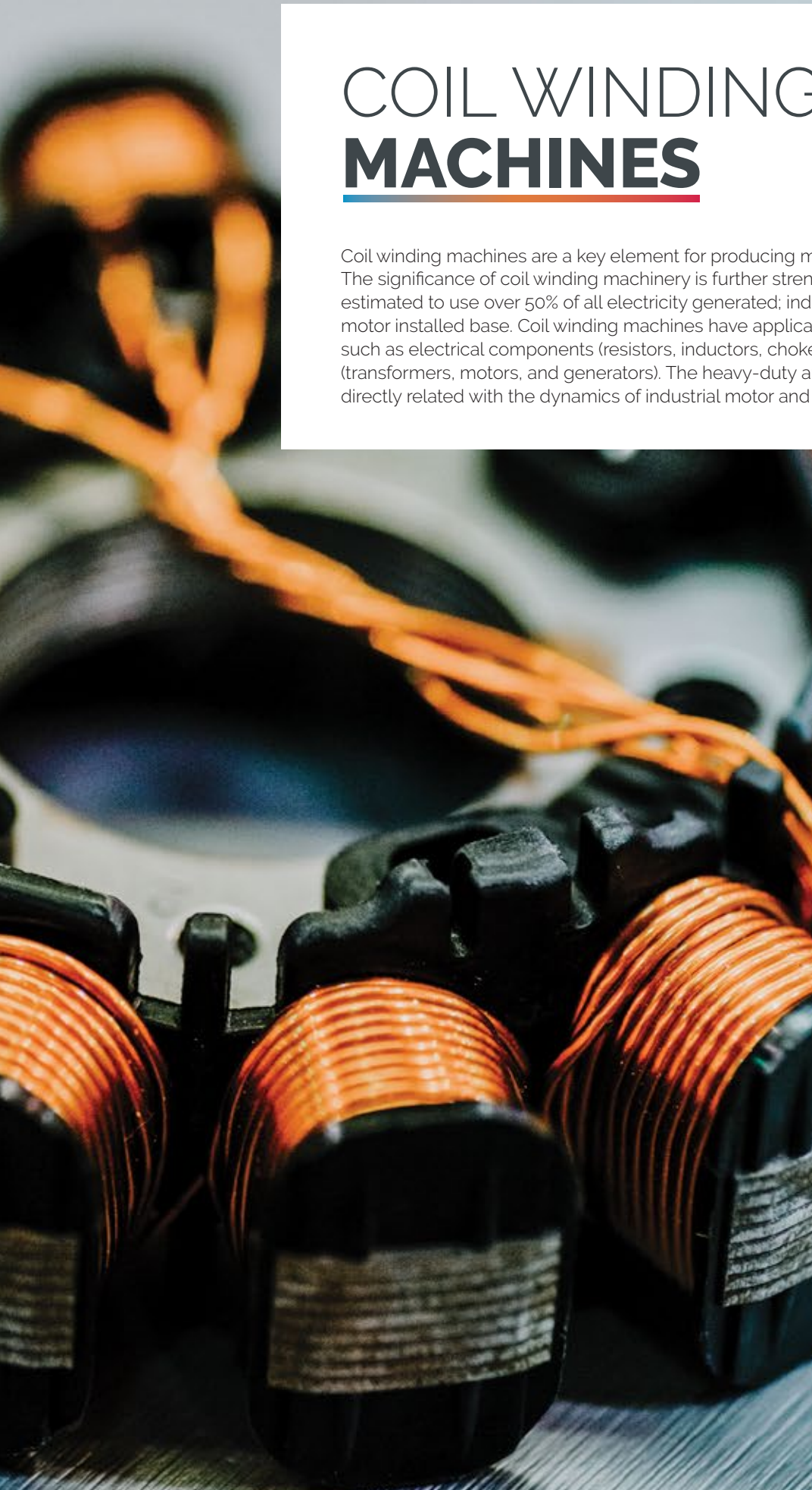
2020 Outlook

Global demand for EV traction motors in 2020 is expected to fall significantly compared to 2019 levels due to the decline in vehicle demand because of the COVID-19 situation. However, PTR believes that while sales may decrease, R&D will continue at least at minimal capacity to not only improve motor performance and efficiency but also optimise manufacturing of the motors for when the industry starts to pick up again.

The current event, combined with supply chain volatility, also strengthens PTR's position that alternative motor solutions utilising minimal or no amounts of rare-earth material will receive increased R&D focus and investment from the OEM, Tier 1 and Tier 2 suppliers moving forward. This will be a slow-moving shift over the next 8 years as the majority of the market remains dependent on China as the dominant refining country for rare-earth materials, commanding over 80% of global rare-earth material refining as materials mined outside of China are often sent to China for the refining process.

COIL WINDING MACHINES

Coil winding machines are a key element for producing major electrical equipment worldwide. The significance of coil winding machinery is further strengthened as electric motors are estimated to use over 50% of all electricity generated; indicating the scale of the global electric motor installed base. Coil winding machines have applications across several industry verticals, such as electrical components (resistors, inductors, chokes, solenoids) and electrical systems (transformers, motors, and generators). The heavy-duty automated winding machine market is directly related with the dynamics of industrial motor and transformer markets.



The coil winding machine industry is expected to see technological progress and overall growth as motors and battery-operated equipment improves. Large industries, such as textile, automobiles, wire welding, transformer, inductors, motors, relays and chokes use coil winding machines in diverse applications. Automation has increased the precision and reduced human error, material waste and unwanted tension on coils. Coil winding machines have also significantly broadened their use and applications by simplifying intricate processes. As they have in many other industries, programming and automation have solved multiple issues and have given the coil winding machine industry a push.

Key Applications & Trends in the Coil Winding Machinery Market

The textile industry is one of the promising industries due to advancements in 3D printing, material specifications and pleating, advanced knitting laser and digital printing and introduction of nanotechnology. These are complex machine-dependent activities which are, in turn, dependent on coil winding machines. Thus, the boom in the textile industry is going to be directly proportional to coil winding machinery demand. China is the top producer in the textile industry followed by Germany, Bangladesh, and Italy. China produces half of the world's textile industry, providing opportunities for the coil winding machinery suppliers worldwide.

As the applications of coil winding machines vary significantly, suppliers with an ability to provide custom solutions according to the customer requirements have a better presence in the market. Precision and accuracy to produce coils with very specific characteristics remain the key vendor selection criterion across all applications. Additionally, with the advancements in superconductivity in coils, special purpose winding machines have gained some attention in the recent past which can perform with the highest winding accuracy and constant wire tension.

Coil winding machinery suppliers will also benefit from the increased demand for EVs. Although China is the leading producer for EV traction motors, North America and Europe are expected to gain market share as domestic traction motor supply chains are developed. The fast growth of the EV market has caused the motors and coil winding OEMs to be strategic in developing solutions for the EV applications.

Transformers, the leading electrical market equipment, are all but coils. Special winders are designed for advanced transformers like toroidal transformers. Manual transformer winding machines for small transformers, programmable transformer winders and automatic transformer winders are used for large scale transformers. With increasing penetration of dry type transformers in industrial and renewable applications, strip foil winding machines with higher precision and tension control are gaining more traction. There has been some discussion around the solid-state transformers (SSTs) and potential implications on the coil winding industry in the recent years. However, applications of SSTs are limited due to very high cost as compared with traditional transformers.

CWIEME

Connecting the global coil winding, transformer, electric motor, generator and e-mobility supply chain.

This report was prepared by Power Technology Research and CWIEME. As the leading global platform for the industry, CWIEME connects process machinery, raw materials, components and service providers with manufacturers and industry experts online and offline. It is the largest and only dedicated platform to showcase the latest high-end products and solutions for electric motor, transformer and generator technologies digitally and at events across three regions – EMEA, Asia and Americas.

CWIEME's visitors are specialist design, process and manufacturing engineers, procurement and business professionals from across coil winding, transformer, electric motor, generator and e-mobility manufacturing and technology markets. At CWIEME, they source new suppliers, identify the latest trends in technologies, material and product innovations, as well as meet and network with their peers.

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