

Issue 01 | 2020



# IMPULSE

Transportation

Traction generators  
for hybrid locomotives

EU REGULATION

**TIGHTER DEMANDS ON THE  
ENERGY EFFICIENCY OF ELECTRIC MOTORS**

17<sup>TH</sup> TECHNICAL CONFERENCE

**NEW MOTOR AND DRIVE TECHNOLOGIES –  
ALSO FOR ELECTROMOBILITY**



# TRACTION GENERATORS FOR HYBRID LOCOMOTIVES

Stadler Rail Valencia relies on VEM drives for its EURODUAL locomotives.

Stadler Rail Valencia has placed an order for self-ventilated three-phase asynchronous traction generators from VEM for its EURODUAL hybrid locomotives. These dual-mode locomotives, which have been developed specifically for the European market, can be used either as diesel-electric or electric traction units, and can thus be deployed on both electrified and non-electrified track systems. That enables railway operators to plan more flexibly and to save transport costs. Current operators include, among others, the European Loc Pool (ELP), Havelländische Eisenbahn AG, ITL Eisenbahngesellschaft mbH and a number of railway companies in Norway, Sweden, France and Turkey.



A hybrid locomotive for Havelländische Eisenbahn AG during tests on the Wildenrath Test Oval in North Rhine-Westphalia

## GOOD BUSINESS BEYOND 2020

VEM cultivates numerous contacts at the TRAKO trade fair in Gdansk.



The VEM fair team at TRAKO in Gdansk

“As far as we are concerned, VEM’s participation at the TRAKO trade fair was very successful,” says Hans-Georg Becker, head of transportation sales at VEM. TRAKO is for VEM the second most important transportation fair after Innotrans, but at the same time the most significant get-together for Poland and the Eastern European market in general. It was held in the Polish city of Gdansk from 24<sup>th</sup> to 27<sup>th</sup> September 2019. This was already the 5<sup>th</sup> time that VEM had been represented on the joint stand of the Saxon Economic Development Corporation. Intensive contacts were cultivated with partners from the host country, and Hans-Georg Becker reports that “agreements were reached which secure good business even beyond 2020.” Fair meetings with customers from many different countries have laid the foundations for new projects not only in Poland, but also in the Asian region.

# VEM SUPPLIES DRIVES FOR “LEARNING STEEL MILL” IN THE USA

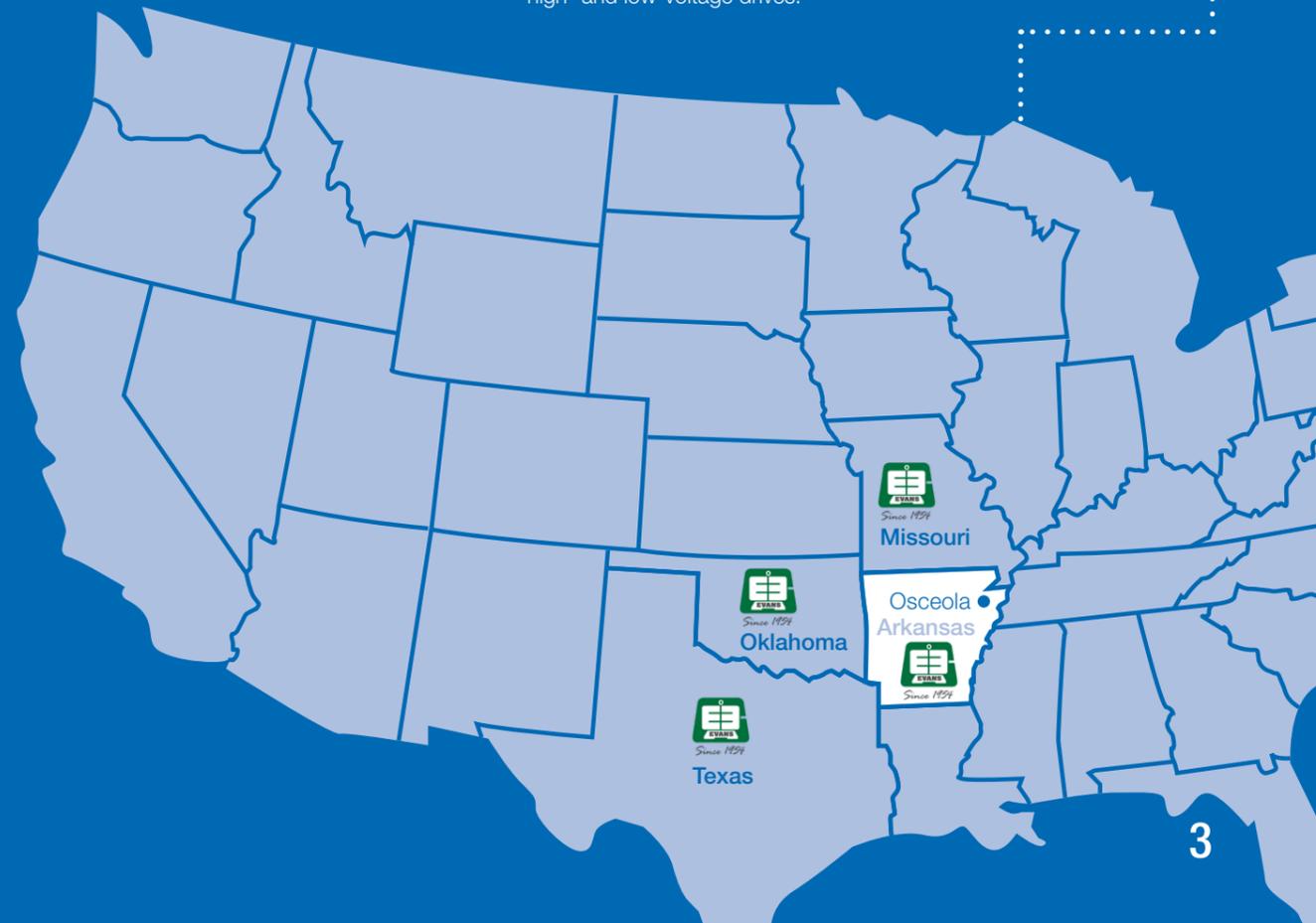
Drives from the VEM locations in Wernigerode and Dresden are also earmarked for the second expansion stage

In 2007, the US steel company Big River Steel opened the most modern and most environment-friendly steel mill in North America at its site in Osceola, Arkansas. The incorporation of digital applications for all process steps formed the basis for the world’s first “learning steel mill”. Electric drives from VEM were at the core of the project from the very beginning: Main drives, roller table motors in versions with ring ribbed housings, special motors for converter-fed operation and energy-saving motors of efficiency class IE3 help to ensure uninterrupted production. VEM has now also been chosen to supply drives from the VEMoSTEEL product family in sizes from 132 to 710 for the latest expansion of the mill. Deliveries for this second expansion stage are scheduled for completion during 2020.

Big River Steel produces a broad spectrum of high-quality steels, for example pipe steels, silicon electrical steels and AHSS grades for the US automobile industry.

**Further VEM service partner locally and for Big River Steel**

To safeguard long-term process reliability in the future, VEM already signed an official service contract with the American company Evans Enterprises, Inc. in spring 2019. Evans operates more than 10 service workshops in Arkansas, Missouri, Oklahoma and Texas. Only recently, the workshops in Arkansas and Oklahoma were successfully audited by VEM and the cooperation between the two companies was raised to the next level. The American specialist for electromechanical machines, motors and generators is now an official VEM service partner with authorisation to perform maintenance and repairs and to supply spare parts for VEM’s high- and low-voltage drives.



# TIGHTER DEMANDS

## ON THE ENERGY EFFICIENCY OF ELECTRIC MOTORS IN EUROPE

Customers have eighteen months to bring their machines and equipment into line with the stipulations of a new EU regulation.

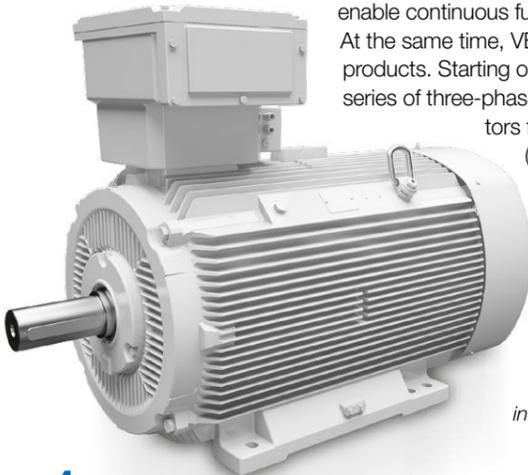
Faced with ongoing climate change and the ensuing urgency of responsible resource management, the EU has revised and realigned its climate policy objectives with a view to promoting further energy savings and reducing carbon emissions. By 2030, greenhouse gas emissions in Europe are to be reduced by at least 40% compared to 1990, the share of renewable energies in the overall mix is to be increased to 27% and final energy consumption is to be reduced by 27%. To this end, a new package of legislation aimed at raising energy efficiency by 30% compared to 2005 was passed in 2018. The stipulations include tighter demands on the energy efficiency of motors and frequency converters. The current Regulation (EC) No. 640/2009 is to be repealed with effect from 30.06.2021 and replaced with the new Regulation (EU) 2019/1781. The new rules are to become effective on the market in two phases starting on 1st July 2021 (see upper table opposite). Customers thus have just over eighteen months to adapt their products in accordance with the new EU requirements.

### VEM is prepared

There are many different motor technologies which can be chosen to achieve the efficiency class stipulated by the new regulations for a particular application. Already today, VEM has updated many motors from its portfolio such that corresponding drives comply with the new EU demands. The company is thus a good partner for customers in all matters concerning energy efficiency.

Through a diversity of innovations, VEM strives constantly to reduce the overall losses of its motors. Higher-quality materials, optimisation of the stator and rotor designs, improved bearings and advanced ventilation concepts enable continuous further reductions.

At the same time, VEM is developing new products. Starting out from the proven series of three-phase asynchronous motors for efficiency class IE3 (Premium Efficiency), further developments targeted implementation of the demands



Three-phase motor with an output of 500 kW for efficiency class IE3 (Premium Efficiency) in accordance with Regulation (EU) 2019/1781

contained in the new regulations for an extended output range and for higher pole numbers.

- Extension of the output range up to 710 kW and for 8-pole motors from 0.75 kW to 450 kW has already been realised and the motors are available.
- Explosion-protected three-phase motors with protection type "eb" (Increased safety) already meet the requirements of efficiency class IE2, as stipulated by the new regulations with effect from 1st July 2023, in the output range from 0.12 kW to 320 kW.
- Explosion-protected three-phase motors with protection type "ec" (Increased safety) similarly already meet the requirements of efficiency class IE3, as stipulated by the new regulations with effect from 1st July 2021, in the output range from 0.12 kW to 710 kW.
- Explosion-protected three-phase motors with protection type "d/de" (Flameproof enclosure) already meet the requirements of efficiency class IE3, as stipulated by the new regulations with effect from 1st July 2021, in the output range from 0.75 kW to 355 kW.
- Explosion-protected three-phase motors with protection types "tb" and "tc" (Protection by enclosure) similarly already meet the requirements of efficiency class IE3, as stipulated by the new regulations with effect from 1st July 2021, in the output range from 0.12 kW to 710 kW.
- Motors of the new three-phase asynchronous series are also offered for efficiency class IE4 (Super Premium Efficiency). Motors for this class are already available ahead of the deadline of 1st July 2023 in 2- and 4-pole versions for outputs from 75 kW to 1,000 kW. Motors with 6 and 8 poles are in preparation.

For applications where variable-speed three-phase drives can be used, VEM offers a range of permanent-magnet synchronous motors and synchronous reluctance motors. They meet the efficiency requirements of IE4 or even IE5 in accordance with the standard IEC 60034-30-2 (Efficiency classes of variable-speed AC motors). To be able to use these motors, however, it is always necessary to provide a drive controller. VEM is thus well positioned to satisfy all customer demands arising in connection with the latest and any future regulations.

### New Regulation (EU) 2019/1781 for motors and frequency converters from 01.10.2019

| Scope of validity                   | Year and minimum efficiency requirement (since 2016) |             |             |      |      |          |          |          |      |                       | Portfolio of available VEM motors Status 31.10.2019 |  |
|-------------------------------------|--|-------------|-------------|------|------|----------|----------|----------|------|-----------------------|---|--|
|                                     | 2016   | 2017        | 2018        | 2019 | 2020 | 30.06.21 | 01.07.21 | 2022     | 2023 | further years         |   |  |
| <b>AC induction motors ≤ 1000 V</b> |  |             |             |      |      |          |          |          |      |                       |   |  |
| 0.75 to ≤ 7.5 kW                    | 3 ~, 2-, 4-, 6-pole                                  | IE2         | IE2+VSD/IE3 |      |      |          | IE3      |          |      |                       | 0.75 to 710 kW                                      |  |
| 7.5 to ≤ 375 kW                     | 3 ~, 2-, 4-, 6-pole                                  | IE2+VSD/IE3 |             |      |      | IE3      |          |          |      |                       |   |  |
| 375 to ≤ 1,000 kW                   | 3 ~, 2-, 4-, 6-pole                                  |             |             |      |      | IE3      |          |          |      |                       |   |  |
| 0.75 to ≤ 1,000 kW                  | 3~, 8-pole   |             |             |      |      | IE3      |          |          |      | 0.75 to 450 kW        |   |  |
| 0.75 to ≤ 1,000 kW                  | ATEX/ brake motor*                                   |             |             |      |      | IE3      |          |          |      | Ex ec: 0.12 to 710 kW |   |  |
| 75.0 to ≤ 200 kW                    | 3 ~, 2-, 4-, 6-pole                                  |             |             |      |      |          |          |          |      | IE4                   | 2- and 4-pole                                       |  |
| 0.12 to ≤ 1,000 kW                  | Increased safety Ex eb                               |             |             |      |      |          |          |          |      | IE2                   | 0.12 to 320 kW                                      |  |
| 0.12 to ≤ 0.75 kW                   | 3 ~  |             |             |      |      | IE2      |          |          |      | 3~, 0.12 to 0.75 kW   |   |  |
| ≥ 0.12 kW                           | 1 ~  |             |             |      |      |          |          |          |      | IE2                   |   |  |
| <b>Frequency converters</b>         |  | 2016        | 2017        | 2018 | 2019 | 2020     | 30.06.21 | 01.07.21 | 2022 | 2023                  | further years                                       |  |
| 0.75 to ≤ 1,000 kW                  |  |             |             |      |      | IE2      |          |          |      |                       |   |  |

\* Brake motors where the efficiency can be determined for the motor without brake

### Motor technology and corresponding efficiency options

| Motor technology                                       | Mains start-up | IE1 | IE2       | IE3       | IE4       | IE5       |
|--|----------------|-----|-----------|-----------|-----------|-----------|
|  |                | ▼   | ▼         | ▲         | ▲         | ▼         |
| Three-phase squirrel-cage induction motor              | yes            | ok  | ok        | ok        | difficult | difficult |
| Induction motor with wound rotor                       | yes            | ok  | ok        | ok        | difficult | no        |
| Single-phase induction motor (one capacitor)           | yes            | ok  | difficult | no        | no        | no        |
| Single-phase induction motor (two switched capacitors) | yes            | ok  | ok        | difficult | no        | no        |
| Permanent-magnet synchronous motor                     | no             | ok  | ok        | ok        | ok        | ok        |
| Synchronous motor with wound rotor                     | some           | ok  | ok        | ok        | ok        | ok        |
| Permanent-magnet motor for mains start-up              | yes            | ok  | ok        | ok        | ok        | ok        |
| Synchronous reluctance motor                           | some           | ok  | ok        | ok        | difficult | no        |

# UPGRADED TEST SYSTEM FOR CONVERTER-FED MOTORS

The VEM specialists in Zwickau can in future look forward to extended testing capacities for motors in the lower output range.



André Schmidt, head of testing at VEM in Zwickau, during the testing of a motor

Customers are showing increasing interest in synchronous reluctance motors from VEM. This development is only logical. After all, this technology enables converter-fed drives to be operated over an extended variable-speed range. Furthermore, such drives display a very high level of efficiency, which helps to cushion costs in times of ever stricter EU-wide requirements relating to high energy efficiency. The fact that the motors can be manufactured without rare-earth elements is another important factor. Consequently, VEM has stepped up its investments in testing facilities at the Zwickau location. One of the five systems is being upgraded accordingly by test stand supplier Vogelsang & Benning. It will in future be able to verify the compliance of converter-fed motors with outputs between 250 W and 5.5 kW. Once the new equipment is commissioned at the beginning of 2020, it will be possible to record data from the link between electric motor and frequency converter and data on the power input from the mains supply to the frequency converter simultaneously. In this way, VEM motors in Zwickau is extending the scope of its testing facilities to include 6-channel measurements for the lower output range.

## PASSED WITH FLYING COLOURS

**Successful renewal audit for UL-classified motors at VEM in Zwickau**

After the audit is before the audit. In 2018, the type testing department at VEM's Zwickau location successfully completed a UL audit. The original product inspection and certification results must now be confirmed by Underwriters Laboratories (UL for short) on an annual basis. A renewal audit took place in October 2019, and was similarly passed with flying colours. This means that the VEM location in Zwickau can

continue to satisfy the growing demand from customers for UL-classified motors. This year, the UL audit will also cover the newly upgraded test system which verifies the compliance of motors with outputs between 250 W and 5.5 kW.



View of the large machine test bed at VEM in Dresden, where the customer acceptance testing was performed

## INNOVATIVE GEAR UNIT WITH ELECTRICAL POWER SPLITTING

**RENK chooses VEM as its partner for development of a special superimposition motor.**

Where high-power drives are required to operate within a limited speed range and under particular ambient conditions, for example in explosive atmospheres, the speed superimposition of planetary gearing systems plays an important role. To date, this was generally realised by way of hydraulic couplings based on the Föttinger principle, in other words with hydromechanical torque converters. The hydraulic coupling controlled the power transmission and thus varied the drive output. Power which is removed from the main drive system in this way is naturally lost as far as the drive is concerned. With electrical superimposition, on the other hand, this problem is overcome by way of energy recovery via a converter.

Under the name RECOVER®-E, RENK has now developed a gear unit which realises speed superimposition electrically – a solution which does away with the large quantities of oil required by a torque converter. As hydrodynamic drives are significantly inferior to their electric counterparts in terms of efficiency, RECOVER®-E can point to a much higher degree of efficiency compared to the previous hydrodynamic technology. Planetary gearing between the high-power drive and the driven machine provides for the necessary transmission, e.g. to drive a compressor. A second motor, the so-called superimposition motor, takes care of speed variability.

For this superimposition motor, RENK opted for cooperation with VEM. The motor was designed as a low-voltage asynchronous motor with special slide bearings and water-jacket cooling, and is to be fully integrated into the overall solution. This superimposition motor operates as a motor in the principal direction of rotation and as a



Representatives from Renk during acceptance testing at VEM

generator when rotated in the opposite direction, and in doing so either increases or reduces the speed at the gear unit output relative to a basic speed. The VEM superimposition motor has already been tested successfully under full load and even exceeded all demands specified by the customers.

In February 2020, we will be inviting RENK customers from all over the world to a presentation of RECOVER®-E.



# SYNCHRONOUS MOTORS IN THE SPOTLIGHT

Broad diversity of topics characterised the two-day event in Wernigerode.

## A DATE FOR YOUR DIARY

The 18<sup>th</sup> Technical Conference will be taking place on **29<sup>th</sup> and 30<sup>th</sup> September 2020** under the banner "Electric motors and drive systems – Where is drive technology heading?". The venue will again be the Harzer Kultur- & Kongresshotel (HKK) in Wernigerode. You will be receiving an invitation from VEM in good time.

Developments in synchronous motors for the most varied applications and situations, including the testing of such motors, were a spotlight topic of the two-day Technical Conference which took place at the Harzer Kultur- & Kongresshotel (HKK) in Wernigerode on 18<sup>th</sup> and 19<sup>th</sup> September 2019. Some 20 presentations gave an insight into the latest branch trends and formed a basis for intensive discussions among the 200 participants from 11 different countries.

Another important subject was digitisation and the new opportunities this brings for product development and services relating to drive technologies. Broad scope was also given to presentations of new motor and drive technologies for electromobility. With global recognition of an imperative urgency to realign current climate policies, the presentation on forthcoming EU regulations to raise energy efficiency was even more topical than ever before.



### Jens Proske

Technical manager at Sachsenwerk and CTO of the VEM Group



"VEM has always been a source of 'innovative products for a traditional branch' – and that was what the 17<sup>th</sup> Technical Conference was all about. Those products were destined above all for the West European market, requiring strict compliance with the corresponding EU legislation. Energy-efficient machines with high efficiency ratings, motor monitoring with VEMoDiAC, or VEMoDRIVE and complete drive systems were thus just a few of the relevant topics.

Since the acquisition of our company group by the new Chinese owner, Mr. Wang, particular attention has been paid to enabling also stronger participation in the growth markets of Asia in the future. In this context, it is necessary to expand the global market presence of VEM in practically all sectors for low- and high-voltage machines. This requires a review of the existing motor series and the development of new series which have not belonged to the VEM product portfolio in the past. At the same time, cooperation between the factories in China and Germany must be intensified. In other words, the list of tasks to be solved within the VEM Group has hardly become shorter."



### Ronny Tschannerl

g-foxx GmbH



"The subject of energy efficiency has accompanied me for many years, first as an electrical machine engineer and later at the research institute. This gave rise to the idea of measuring load profiles on uncontrolled drives in order to spot energy-saving potential and thus promote energy optimisation. Practice has shown that far too many over-dimensioned or subsequently modified motors are operated in the lower output range. And many operators are unaware that this reduces the efficiency of the drive. According to estimates, optimisation of just 1% of the inefficient or poorly dimensioned systems on the market could already save 1.5 billion kW/h.

We thus decided to found a start-up and joined forces with VEM as our practice partner to develop the IoT sensor "VEMoDiAC-Sens". As g-foxx GmbH, we are already able to offer a complete solution for communication, analysis and visualisation of the measurement data. Using our IoT system, we measure the capacity utilisation of a motor installation and can then present an initial assessment of possible energy savings. At the same time, our customers can define alarms for vibration- or output-related problems via an online dashboard. The device functions without a separate power supply by tapping into the existing power supply of the motor itself. Motors from VEM can already be fitted with the VEMoDiAC Sens sensor before they leave the factory, and a corresponding order option is now available in the electronic catalogue. To support our customers, we are further expanding the sensor-gateway-cloud system and can already provide a ready-to-use system."

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on next  
page

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**Sascha Neusüs**  
Darmstadt University of Technology



“Synchronous reluctance machines are a good example for innovations which benefit a traditional branch. In the past, motors needed a rotor winding in order to enable mains start-up. Thanks to the incorporation of power electronics and converter technologies, synchronous reluctance motors without a starting winding also achieve very high levels of efficiency. VEM is one of those leading manufacturers whose further developed synchronous reluctance motors achieve higher levels of efficiency than asynchronous motors and thus enjoy a stronger standing on the market.

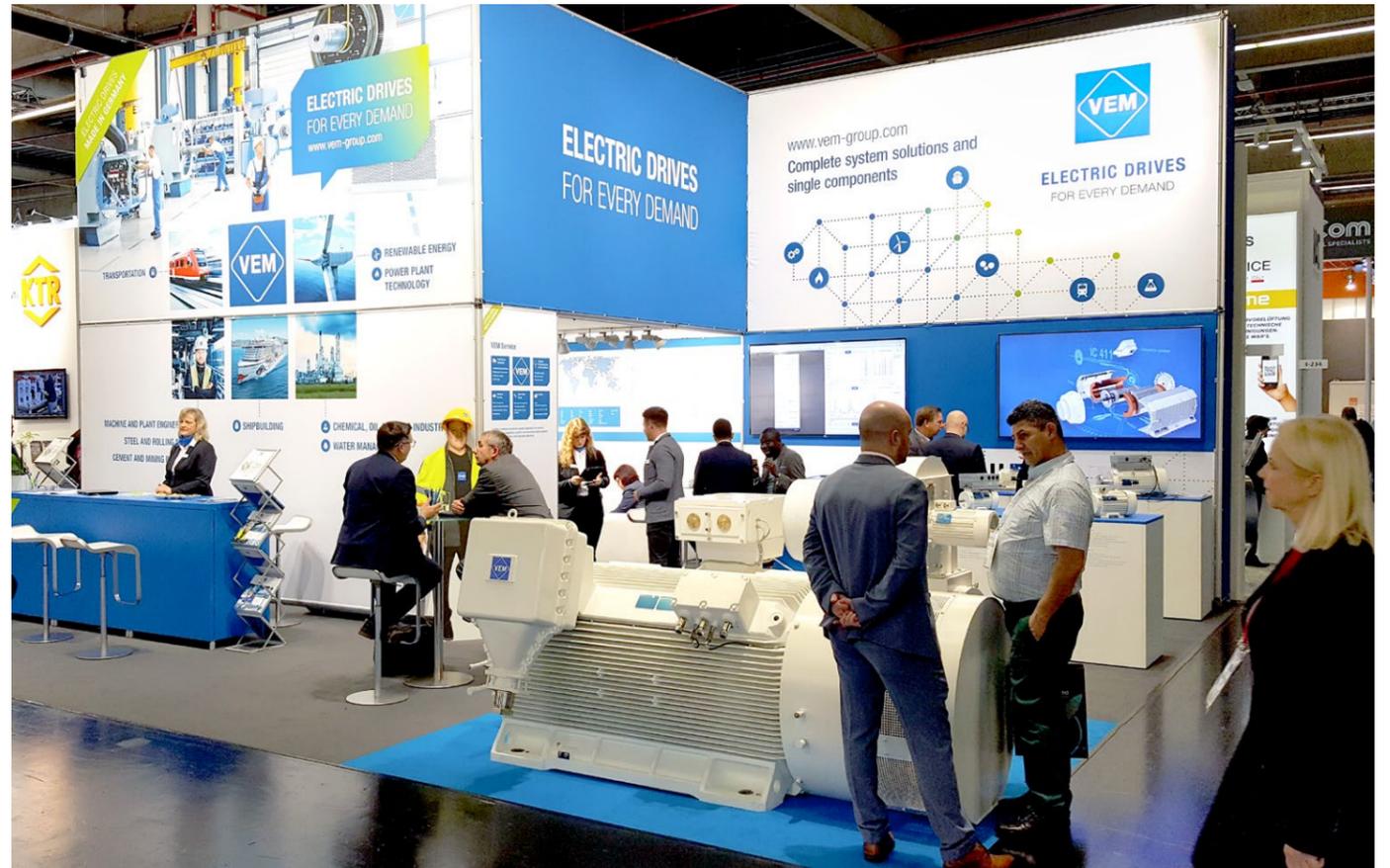
The elimination of a rotor winding means reduced materials input, a longer service life, lower energy consumption and thus greater energy efficiency. In pump and fan applications, in particular, this drive technology is able to play out its strengths to the full. At our university's Institute of Electrical Energy Conversion, my Master dissertation triggered further research on synchronous reluctance motors together with an industry partner. I am very pleased to be able to present the results at the Technical Conference.”

**Oleg Moros**  
VOLABO GmbH



“Our business start-up concerns itself with electromobility. It is now more than three years ago that we began our development of ISCAD, a high-phase cage structure for electrical machines and a power electronics concept enabling creation of an efficient 48 V high-power drive. It currently achieves the highest power output in the chosen voltage range below the shock-hazard protection limit. The concept is already being used in electric vehicles, and adaptations for other applications are planned. But that is only the first step. This very innovative field of drive engineering can build upon known technical developments to serve all branches of mobility. ISCAD is equally suitable for use in commercial vehicles, for electrically driven flight and for boats. Industry and agriculture are further areas which promise a multitude of applications, for example in forklift trucks and similar handling equipment, but at the same time also in large agricultural machines. Numerous overlaps exist between industrial applications and vehicle engineering.

It is important to us to offer an electrically safe drive solution which achieves high power levels and high efficiency without the use of rare-earth elements. After all, from a global perspective, it would be fatal to simply replace one finite resource, like oil, with another scarce resource whose exploitation comes at such a heavy cost for whole communities.”



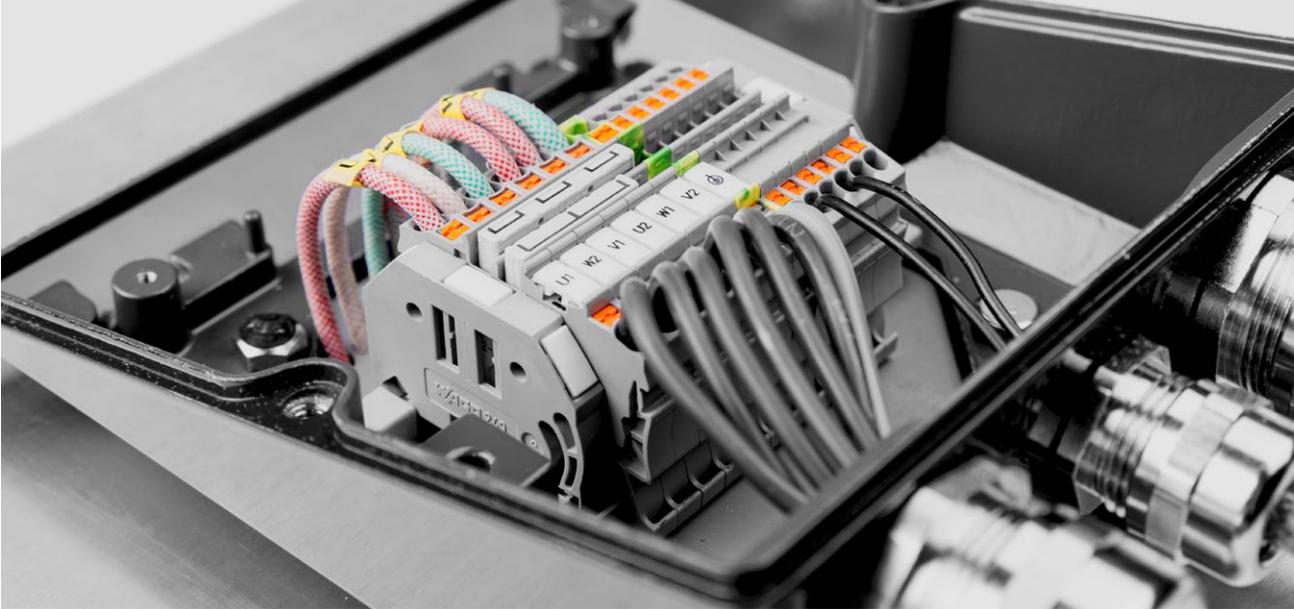
The 76 m<sup>2</sup> VEM stand at SPS was packed with innovations for both high- and low-voltage applications.

# TRADITION MEETS INNOVATION

**In line with the motto “Bringing Automation to Life”, VEM used its long standing participation at the SPS trade fair to present its own visions for the future of production: IE5, explosion-proof machines, motor monitoring.**

A new series of synchronous reluctance machines in sizes 80 to 132 attracted a constant stream of visitors to the VEM stand. Alongside the very high efficiency at IE5 level, it was above all the attainable speeds of up to 8000 rpm which led to various discussions and enquiries. There was an equally positive response to the availability of a full range of German-manufactured non-Ex- and Ex-d machines with cooling type IC 411, especially among the major OEMs. A number of enquiries regarding orders in combination with a frequency converter have already been received. Further certification approvals are planned for this year. Another development which

met with considerable interest was the new VEM motor monitoring system VEMoDiAC. Past conversations had revealed that many customers lacked their own infrastructure for Industry 4.0 applications and were on the lookout for suitable systems. Accordingly, VEM offers its motor sensor VEMoDiAC-Sens both as a stand-alone product and together with a gateway and cloud solution. The concept of measuring electrical parameters directly and tapping into the motor voltage for the required power supply, which eliminates the need for a battery, received unanimous praise.



# EX APPROVAL FOR ALTERNATIVE TERMINAL SYSTEM

Customers in the chemical, oil and gas industries are now able to purchase explosion-protected VEM motors which use the modern and safe VEMoCONTACT terminal system. Based on WAGO terminal blocks, it provides for a uniform connection system from the motor to the switch cabinet.

VEM in Wernigerode is the first manufacturer to offer low-voltage standard and special motors using this alternative connection system in versions with Ex approval. The new EU type examination certificate, which was obtained in summer 2019, has been extended to cover also the new WAGO rail-mount terminal block system.

#### Available with the following explosion protection types:

- Increased safety “eb”
- Increased safety “ec” (old: “n”)
- Protection by enclosure “tx IIY Dx” (dust explosion protection zones 21 and 22)

## AUDIT PASSED

### VEM approved as supplier for air separation plants to be used in semiconductor manufacture at Samsung

The VEM location in Dresden has successfully completed an audit by the companies Praxair, Inc. und Linde AG. Sachsenwerk is thus approved as a potential supplier for Praxair's largest single-client project to date and has already received its first order.

The VEM motors are to be incorporated into air separation plants at a major complex for semiconductor manufacture operated by Samsung in the South Korean province Gyeonggi.

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