RECOVAR®-E.
Variable-speed drives for compressors and pumps.

Superimposition drives. Redefining availability and efficiency of variable-speed drivetrains.

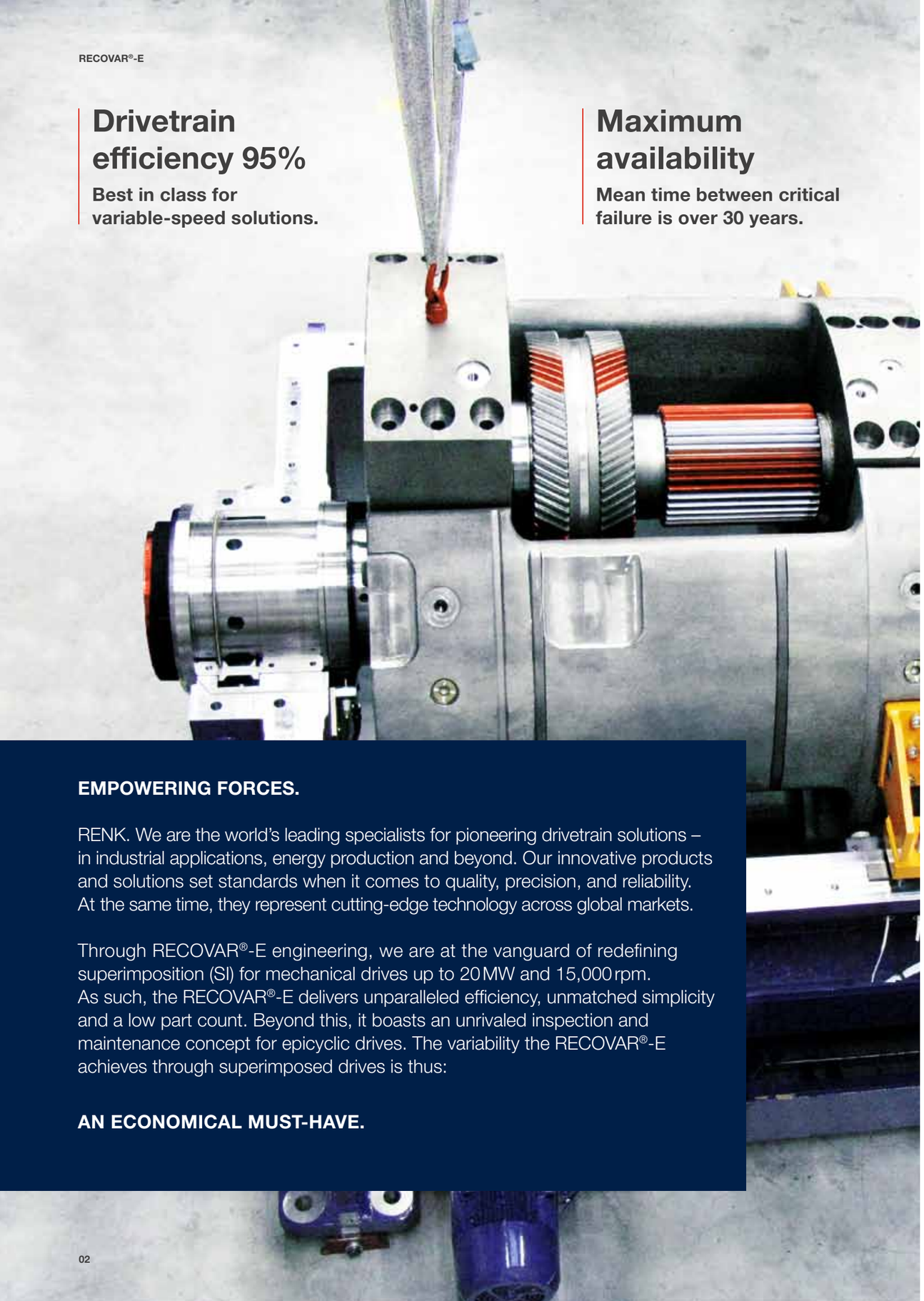
EMPOWERING FORCES.

Drivetrain efficiency 95%

Best in class for variable-speed solutions.

Maximum availability

Mean time between critical failure is over 30 years.



EMPOWERING FORCES.

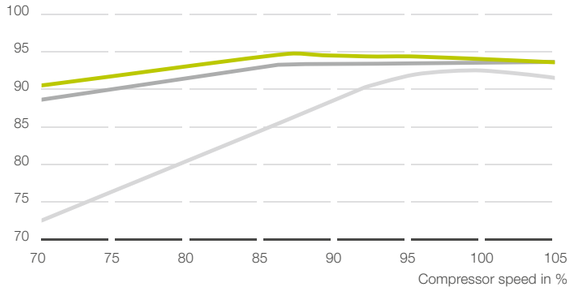
RENK. We are the world's leading specialists for pioneering drivetrain solutions – in industrial applications, energy production and beyond. Our innovative products and solutions set standards when it comes to quality, precision, and reliability. At the same time, they represent cutting-edge technology across global markets.

Through RECOVAR®-E engineering, we are at the vanguard of redefining superimposition (SI) for mechanical drives up to 20 MW and 15,000 rpm. As such, the RECOVAR®-E delivers unparalleled efficiency, unmatched simplicity and a low part count. Beyond this, it boasts an unrivaled inspection and maintenance concept for epicyclic drives. The variability the RECOVAR®-E achieves through superimposed drives is thus:

AN ECONOMICAL MUST-HAVE.

RECOVAR®-E superimposition drive: The cutting edge of efficiency and availability for variable-speed drives.

The RECOVAR®-E provides an unparalleled overall system efficiency of 95% throughout the entire drive system – including the main motor.



Savings compared to conventional solutions through RECOVAR®-E:
Increasing the efficiency of a 10 MW application by 5% represents energy cost savings of at least €200,000 per year.

Over the past twenty years, the industry has developed solutions to operate compressors and pumps at variable speeds in order to preserve energy.

Prior to this, using the throttle was the only way to vary the output of these machines. In many cases, however, this resulted in a loss of more than half the input power.

With the RECOVAR®-E, RENK now offers the latest development for variable-speed solutions. RECOVAR®-E is a reengineered electric SI drive that helps the industry build ideal variable-speed shaft trains. As a hybrid mechanical and electrical solution, it offers the best of both worlds.

By redefining SI for mechanical drives, the RECOVAR®-E delivers the following:

- **Unparalleled efficiency**
- **An unrivaled inspection and maintenance concept for epicyclic drives (similar to that for parallel shaft gears)**
- **An unmatched low part count via direct drive SI**
- **Oil film bearings (SI drives are supported by hydrostatic bearings)**
- **No scheduled mean time between overhauls (MTBO)**
- **Reduced total harmonic grid distortion (THD)**
- **A redundant converter for the superimposition variable-speed drive (VSD)**

RECOVAR®-E in your train:

- Coaxial shaft arrangement
- Very low moment of inertia for direct on-line (DOL) starting
- RENK helps to select/provides the main motor
- Complies with most API 613 requirements
- API 614 oil supply system possible

Short outage time

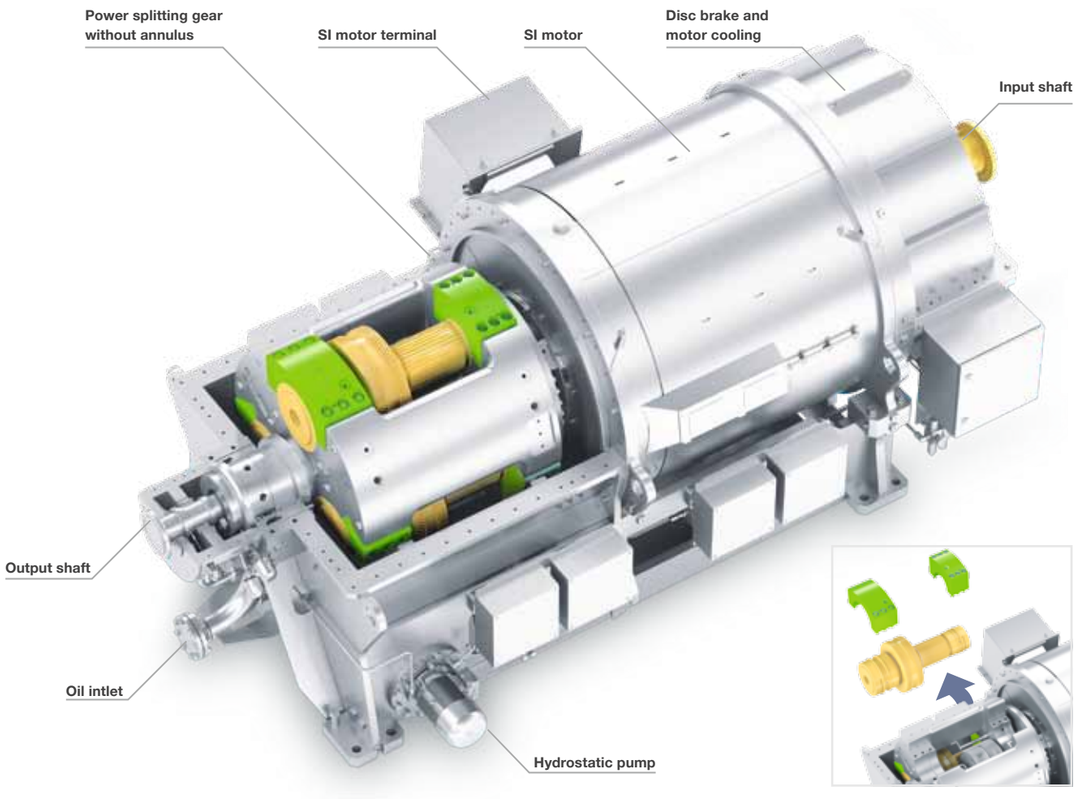
Mean time to repair (MTTR) is 12 hours.

Low inertia

Allows for easy direct on-line starting of motor.

Low total harmonic grid distortion

Ideal for local grids.



Engineered for in situ maintenance.

Most RECOVAR®-E components can be inspected / disassembled with the unit still installed in the shaft train.

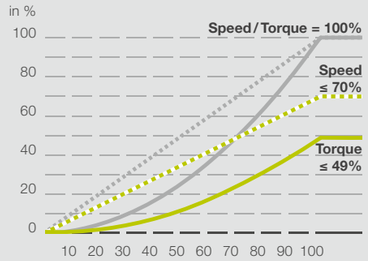
Thanks to its featured horizontal split line, the RECOVAR®-E overcomes the typical maintenance disadvantages associated with epicyclic gears (e.g. those associated with existing SI gear concepts with an annulus). Using the SI motor and the brake, the controller turns one planet after another to the disassembly position.

Following the planets, the central pinions can be easily removed. Since there is no ring gear, the planet shafts are accessible (as is the case in a parallel shaft gear with bearing caps). The planets can be effortlessly disassembled in conjunction with their bearings. Output and input sun gears can also be maintained without any disruption of the casing alignment. This work requires only very limited crane capacity in the shaft axis line.

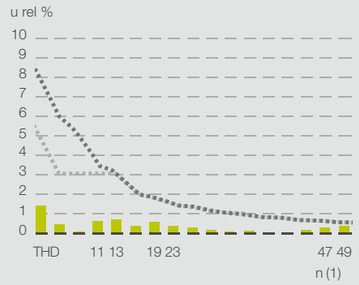
Made for the petrochemical industry.
"A mean time to repair of just 12 hours, 20 years of service life and 5 years of uninterrupted operation according to API 613"

RECOVAR®-E lowers the inertia and the impact on the grid.

RECOVAR®-E improved DOL start of main motor



Harmonics and THD



- **RECOVAR®-E torque at motor shaft**
- **RECOVAR®-E compressor speed**
- **API 613 gear torque at motor shaft**
- **API 613 gear compressor speed**
- **RECOVAR®-E**
- **IEC 61000-2-4 limit for class 1**
- **IEC 61000-2-4 limit for class 2**

Benefits of the RECOVAR®-E for the DOL start of the main motor:

- Facilitated start of main motor / drivetrain
- Reduced thermal stress for motor
- In many cases, no additional measures required (such as low inrush current motor/additional motor-starting devices)
- Reduced costs for main motor
- Improved motor efficiency (compared to low inrush current motor)

RECOVAR®-E improves the direct on-line start of the main motor.

Since the main motors of compressors or pumps usually operate directly on the grid, the requirements for DOL start-up have to be considered.

Thanks to the absence of an annulus, the RECOVAR®-E features very low inertia. In fact, it has by far the lowest inertia of the known solutions for compressor drives. This facilitates the start of the motor. The SI motor can bring the inertia of the high-speed side down to nearly zero. During the first part of the start cycle, the compressor / pump can stand still. At the end, the compressor / pump is only accelerated to minimum speed. This results in a significantly reduced inertia at the point of acceleration. As part of any quotation, RENK can provide the required counter torque for the main drive. To take advantage of this service, please provide the corresponding inertia of your compressor / pump.

Low harmonic distortions.

Particularly in decentralized grids, such as those on offshore oil platforms, harmonic distortion must be prevented. RECOVAR®-E SI drives nearly eliminate the effects of THD.

The SI drive requires only limited power to control and induce variable speeds. Running on 690 V, the drive leverages the advantages of low-voltage (LV) power supplies. This allows a small frequency converter (FC) to be used (in this case, an active-front-end type). Compared to a main drive FC, the RECOVAR®-E FC handles just a fraction of the power. As a result, harmonic distortion is minimized. At the same time, LV service is broadly available, and the limited costs of the FC mean, it can be provided in a redundant setup for critical applications.

A systems comparison for inertia at the motor shaft:

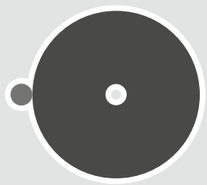
RECOVAR®-E

Inertia **25%**

Hydrodynamic VSD

Inertia **50%**

API 613 parallel shaft gear



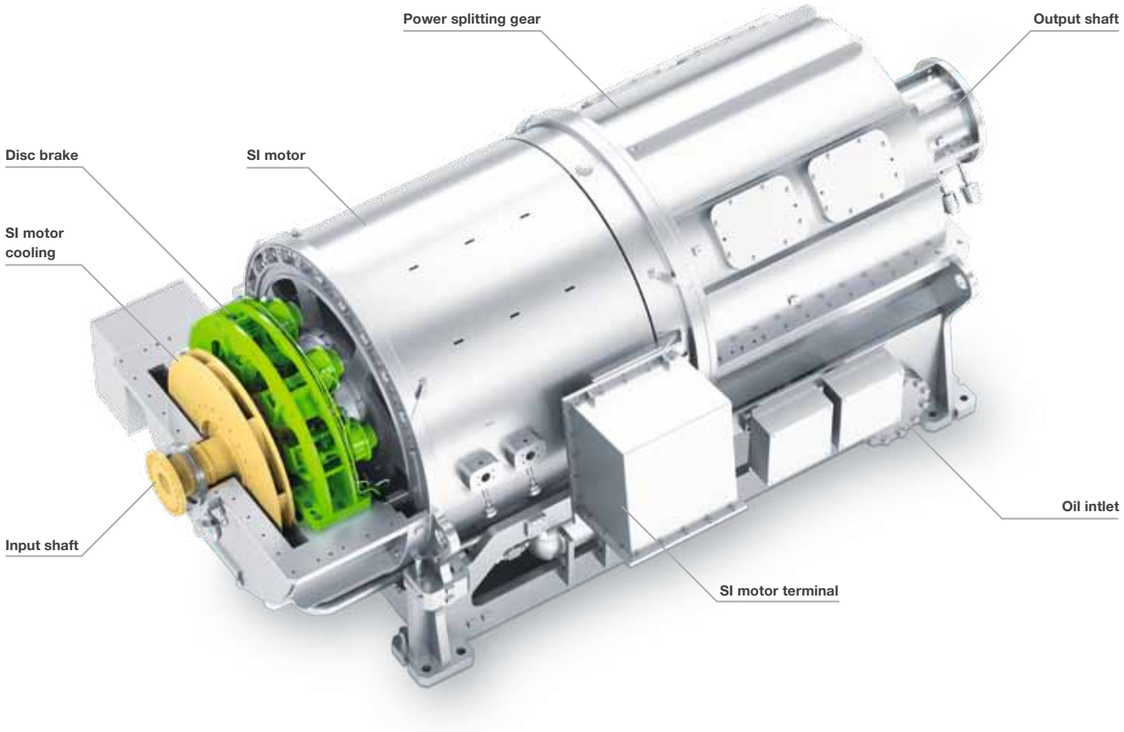
Inertia **100%**

Unparalleled simplicity

Engineered for maximum modularity.

Water, oil or air cooling

SI motor cooling is adapted to site requirements.



The SI motor is an LV multipole induction motor which is water- or oil-cooled. In the event of a power outage, a disc brake safely brings the SI drive to standstill. The RECOVAR®-E can be designed to operate continuously while the the planet carrier is locked.

The SI motor is a core component of the RECOVAR®-E. Thanks to jacket cooling, it is very compact. Where water is not available as a cooling media, gear lube oil can be used. This multipole motor features high efficiency in the transmission of SI power – even at very low speeds. The air in the motor is circulated by an input-shaft-driven fan.

Oil film bearings for all shafts in the RECOVAR®-E are essential for continuous intervention-free operation as required in API 613.

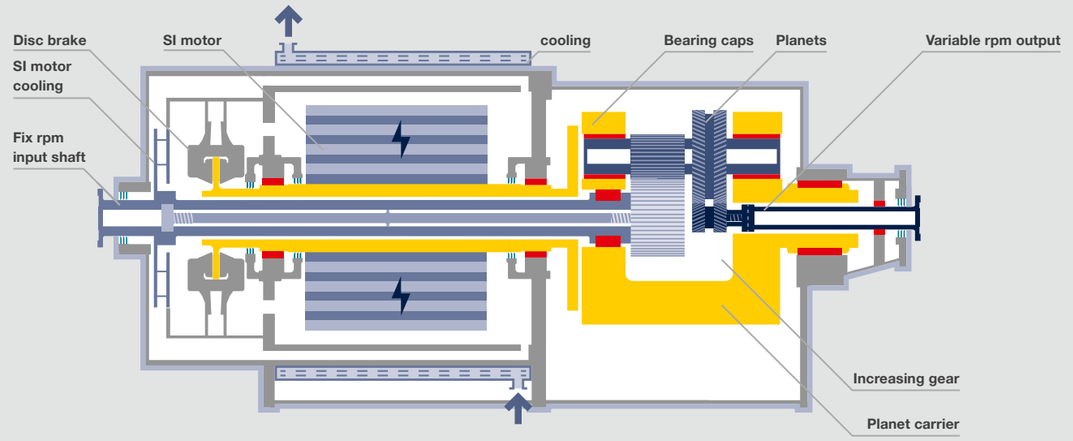
Furthermore, the SI drive bearings are supported by hydrostatic lubrication. This enables the dependable operation at low SI-speeds. The RECOVAR®-E design features planet bearing temperature monitoring by radio-frequency identification (RFID). Data are transmitted wirelessly from the revolving planet.

The SI motor is a state-of-the-art induction motor.
It offers top efficiency even at the lowest speed. The SI can also provide zero speed.

The high torque of this multipole motor allows direct coupling of the SI motor and the planet carrier. The SI motor can be removed without disturbing train alignment.

RECOVAR®-E: engineering excellence. Maximum simplicity. Maximum resilience.

RECOVAR®-E for variable speed applications:
Innovative. Intelligent. Low maintenance.



Superimposition transmission reinvented.

RECOVAR®-E is a cost efficient solution whenever a high speed drive system above 3 MW requires speed control. This is the case for roughly 50% of compression and pumping systems. A system, which has been in operation since 2017, demonstrates that power of 100 MW can be transmitted.

Often medium-voltage motors fed by FCs and parallel shaft gears are selected. Others use epicyclic gears with a hydrodynamic SI drive. The RECOVAR®-E is the drive solution for all of these applications.

The principle of SI is used in the RECOVAR®-E's specific differential gear design to control the output speed in a defined range below and above the natural ratio of the speed increaser.

In conventional SI layouts, the SI drives transmit their torque through complex gearing mechanism on the drivetrain. In the RECOVAR®-E design, by contrast, the SI motor is directly coupled with the planet carrier.

The axis of the RECOVAR®-E input shaft runs through this hollow shaft on the SI motor directly into the speed increaser of the RECOVAR®-E. The speed increaser itself is a 2-stage multi-path parallel shaft gear.

With a mere eleven bearings in total, this design features unparalleled simplicity – particularly when compared to any other SI drive, which has roughly twice the mechanical complexity. Beyond this, the RECOVAR®-E has no working oil, no extra coolers, no extra oil tanks.

50% smaller footprint

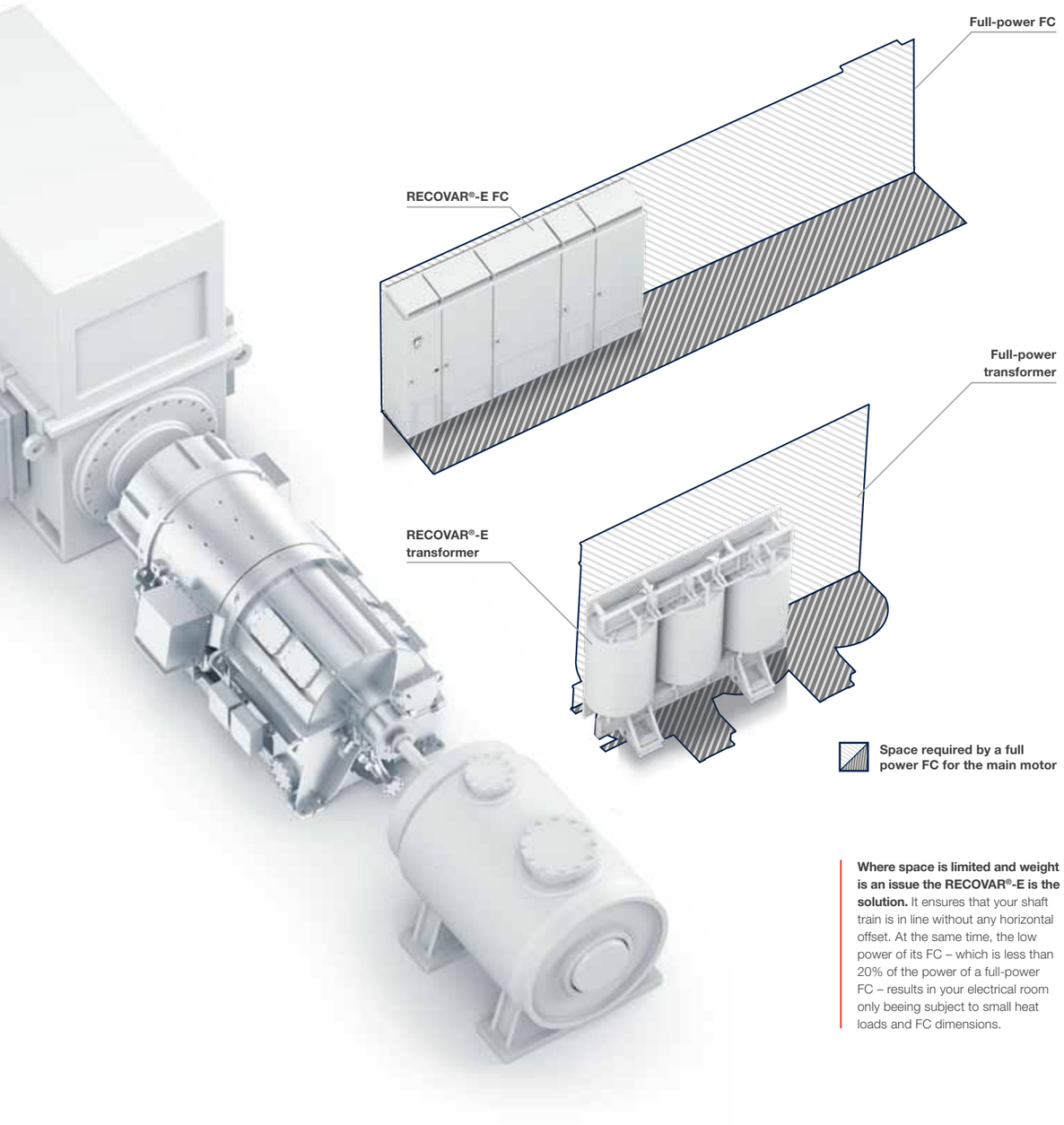
Same output while taking up much less space in the electrical room.

70% less weight

than a full-power FC and transformer.

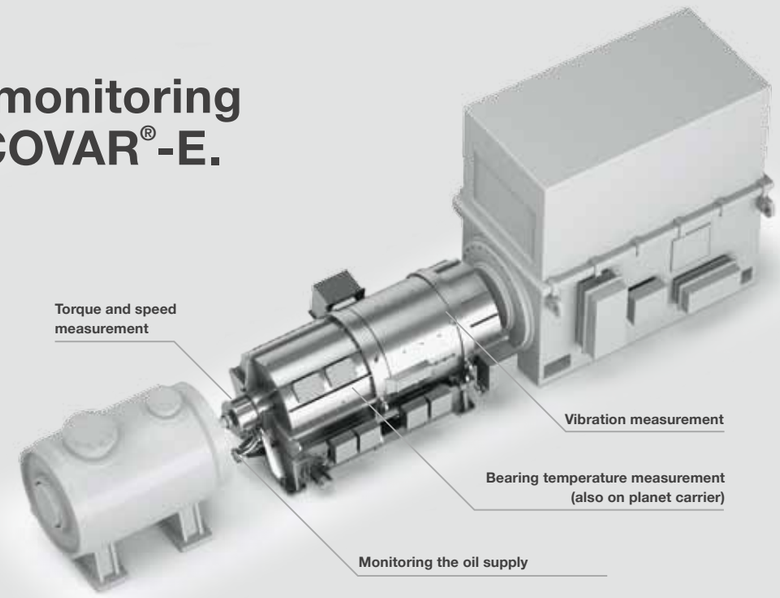
80% less heat load

in the electrical room.



Where space is limited and weight is an issue the RECOVAR®-E is the solution. It ensures that your shaft train is in line without any horizontal offset. At the same time, the low power of its FC – which is less than 20% of the power of a full-power FC – results in your electrical room only beeing subject to small heat loads and FC dimensions.

Innovative monitoring for the RECOVAR®-E.



The optional RENK VIB-Monitor allows for remote inspection.

The RENK VIB-Monitor analyzes all relevant parameters of drives, couplings and gear units. The system logs key data and transmits it to any digital device at any location via high-quality cryptographic encryption standards.

Any performance detail is available on any digital device for any authorized party in the world in real time. If desired, information concerning equipment conditions as well as maintenance recommendations can also be delivered as individual reports. This recording of cross-system conditions is the foundation for the efficient maintenance of the entire system.

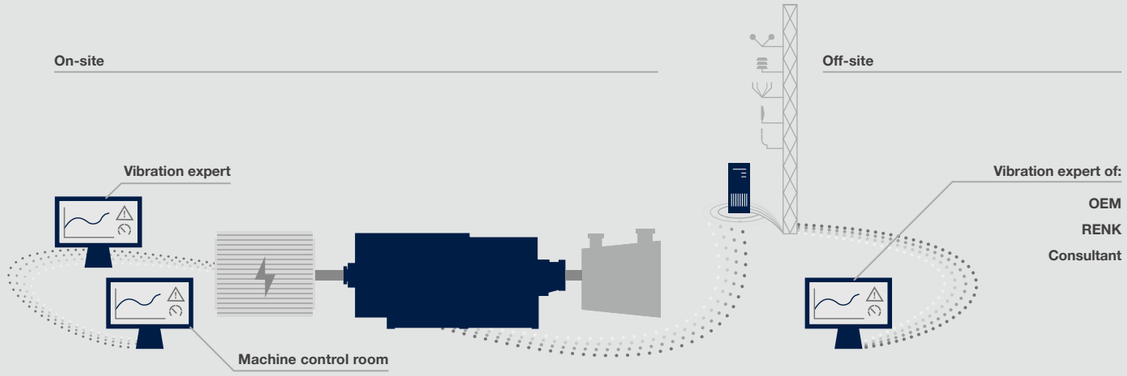
The data is either stored locally or directly in a certified RENK data center through a VPN data line. As a result, highly qualified service personnel can check the system status at any time.

Instrumentation based on API 670 is built into the RECOVAR®-E can monitor the following:

- Shaft vibration for output shaft and SI drive
- Casing vibration
- Temperature for all bearings, including those of the planet carrier
- Brake status
- SI motor winding temperatures
- Lube oil data and condition

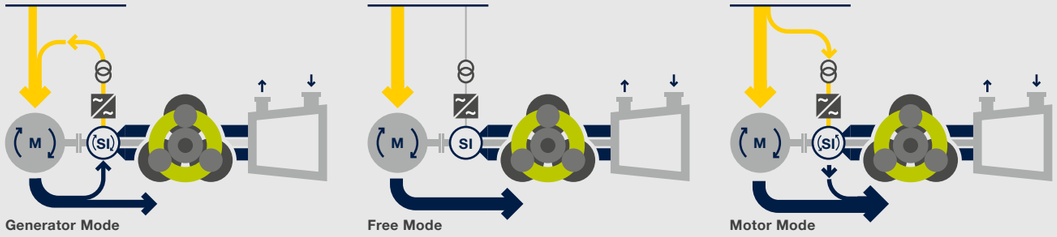
All components in view. With RENK VIB-Monitor, manufacturers and operators have online access to the condition of gearboxes, couplings, bearings and oil units.

Maintenance can be scheduled based on comprehensive historic data collected by the VIB-Monitor instead of inspections and hence can be optimized and reduce downtime.



RECOVAR®-E provides 95% or more total system effciency over a wide range of output speeds – thanks to electric superimposition.

RECOVAR®-E – Electrical and mechanical power flow



Unique design for ultimate performance.

SI in the RECOVAR®-E uses a LV induction motor fed through an active-front-end FC to rotate the planet carrier.

When the speed is increased from a basic gear ratio, the SI motor works as an extra driver. Functioning as a generator, it allows the speed to be decreased below the basic gear ratio.

The SI motor is rated according to the required torque and speed range of your application. The low power and high efficiency of the SI motor and FC boost the efficiency of the RECOVAR®-E to a level beyond that of all other available solutions for variable-speed drives.

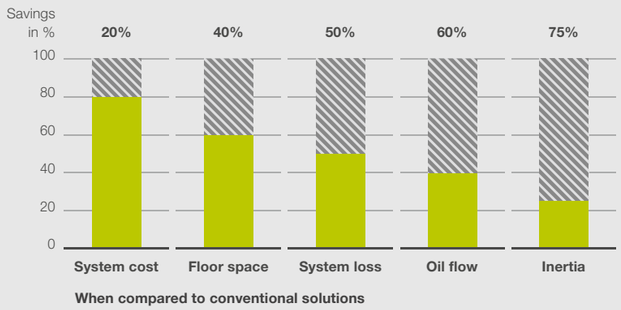
Application range

The RECOVAR®-E is available for a variety of input speeds. The 100% output speed can range from 4,000 to 20,000 rpm.

The speed control range is typically 70% to 105%. Lower control ranges result in even greater efficiencies and lower costs. Higher control ranges are also possible. The efficiencies given here do include the main motor. With the RECOVAR®-E, the drive power is the total of the main motor power and the SI motor power. As a result, part of the drive power comes from the SI motor. RENK is more than happy to quote the main motor which normally is not part of the scope of the RECOVAR®-E.

The RECOVAR®-E is an amplifier for the variable speed of its FC-fed SI induction motor.
The electrical SI provides the RECOVAR®-E with its good system efficiency. In solutions up to 30 MW, the SI motor directly drives the planet carrier. Solutions for up to 100 MW are available with geared SI.

Please contact our sales team for further details.



When compared to conventional solutions

RECOVAR®-E
- Is based on an electric SI drive (with a fraction of the main motor power)
- This results in high efficiency, a small FC and a lube oil system similar to a parallel shaft gear.

ONE SYSTEM, ONE PARTNER.

As your system partner for RECOVAR®-E variable-speed gears
- RENK's scope comprises all mechanical and electrical components from shaft end to shaft end.
- RENK provides torsional shaft train analysis for your entire drivetrain.
- RENK can, upon provision of the grid data, provide you the THD calculation of your grid or sub-grid using SINCAL software.
- RENK will provide you with a counter-torque curve of the main motor to be purchased. RENK can also quote the main motor.
- RENK can provide a sub-control system for the RECOVAR®-E.
- RENK can provide automated and online inspection of the RECOVAR®-E through the RENK VIB-Monitor.

AZHollink

A.Z. Hollink Benelux
Tweelingenlaan 63
7324BK Apeldoorn
The Netherlands
Phone: + 31 (88) 1200 300
Email: info@azhollinkgroup.com

www.azhollink.nl

A.Z. Hollink SA
P.O. Box 1217
New Redruth
Alberton
Phone: + 27 11 907 0477
Phone: + 27 82 825 3880
Email: info@azhollink.co.za

www.azhollink.co.za

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