



Rotating Machines Facility

Nancy, France

The Site

GE Value

- **UNIQUE TEST CAPABILITIES:** up to 18 MW with full VSDS combined or back-to-back testing
- **ADVANCED TECHNOLOGY:** high speed motors from 2 MW/20,000 rpm, to 100 MW/4,000 rpm
- **COMPREHENSIVE RANGE:** Full Medium Voltage motor range with high efficiency and power dense induction machines. Large High Voltage synchronous motors for all general industry and oil & gas applications. Large slow and medium speed motors, PTO-PTI, and Pods including ice class for marine applications
- **HERITAGE:** Over 100 years experience in the design and manufacture of rotating machines

Overview

GE Power Conversion Nancy

Manufacturing of Rotating Machines

Research & Development

Strong activity on IP and patenting, with 56 patents active in 2019, mainly on High-Speed and Renewable technologies

End-markets

Oil & Gas
Marine
Industry
Power & Water
Renewables
Metals

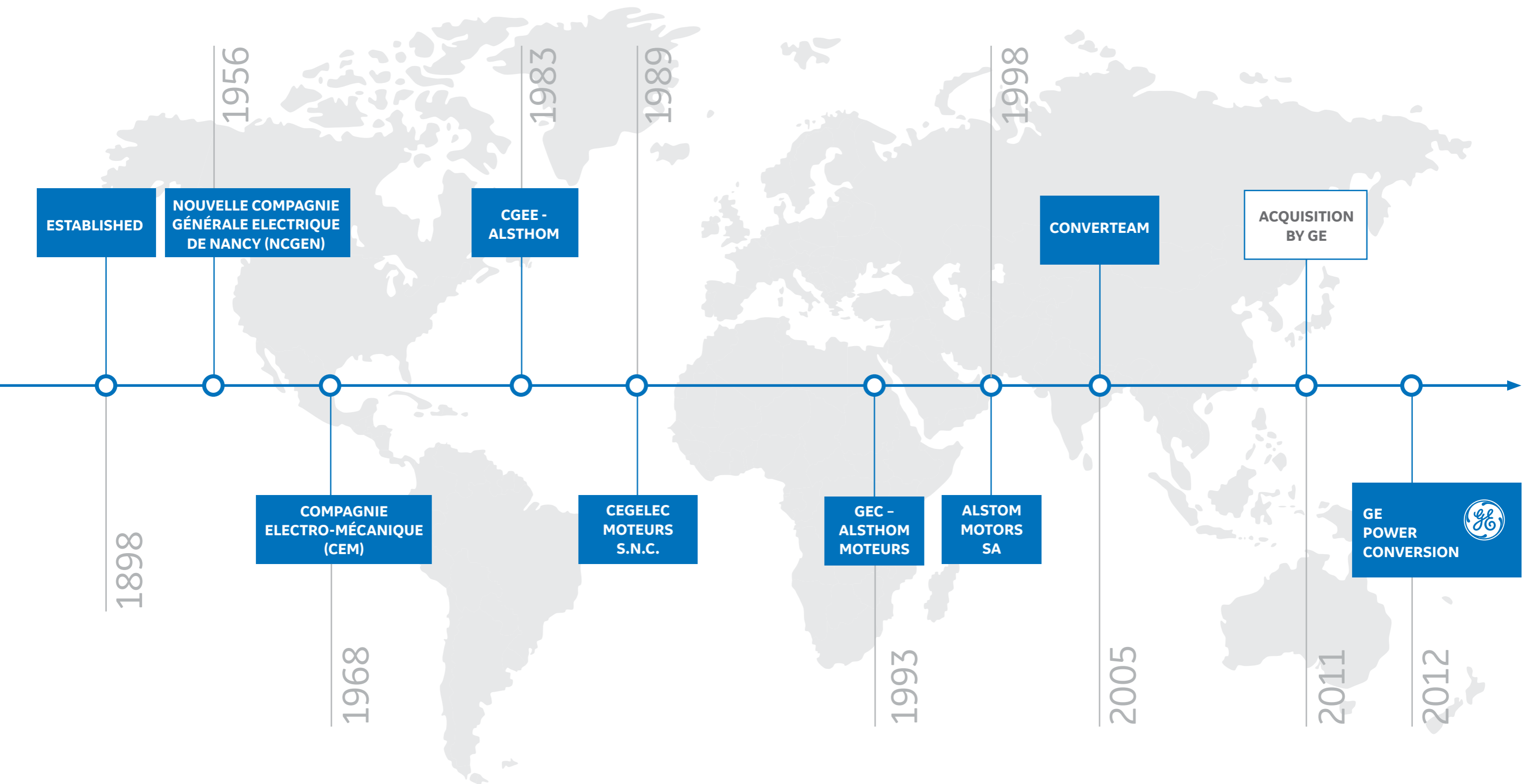


- ✓ **Center of Excellence** for large induction and synchronous electrical machines
- ✓ **Established 1898** (new factory in 2002)

- ✓ Located in **central Europe**
- ✓ **Direct links to extensive transportation** network including waterways and by road
- ✓ **Fast access** from Paris (~1h30 TGV train)



A Hundred Years Of Global Experience

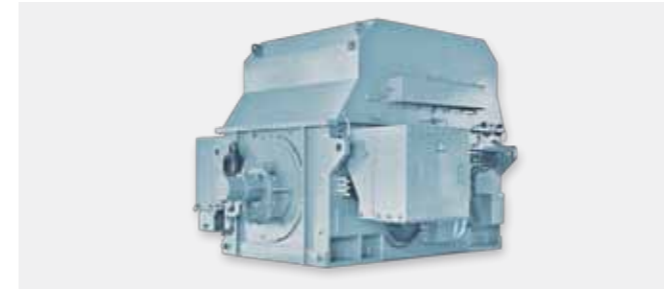


About GE's Power Conversion business

GE's Power Conversion business applies the science and systems of power conversion to help drive the electric transformation of the world's energy infrastructure. Designing and delivering advanced motor, generator, drive and control technologies that evolve today's industrial processes for a cleaner, more productive future, it serves specialized sectors such as energy, marine, industry and all related services.

Our Products and Services

PRODUCT PORTFOLIO



INDUCTION MOTORS

UP TO 40 MW



LOW SPEED MOTORS

INDUCTION AND SYNCHRONOUS, UP TO 40 MW



HIGH SPEED SYNCHRONOUS MOTORS

UP TO 100 MW/1,800 RPM



HIGH SPEED INDUCTION MOTORS

STAND-ALONE OR INTEGRATED, UP TO 20 MW/18,000 RPM



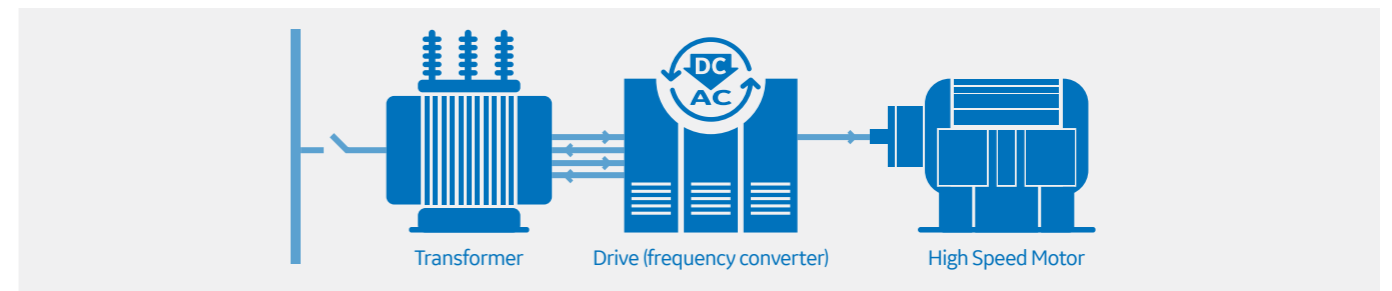
TWO POLE TURBO MOTORS

UP TO 100 MW



PODDED PROPULSION MOTORS

SEAJET™ PODS



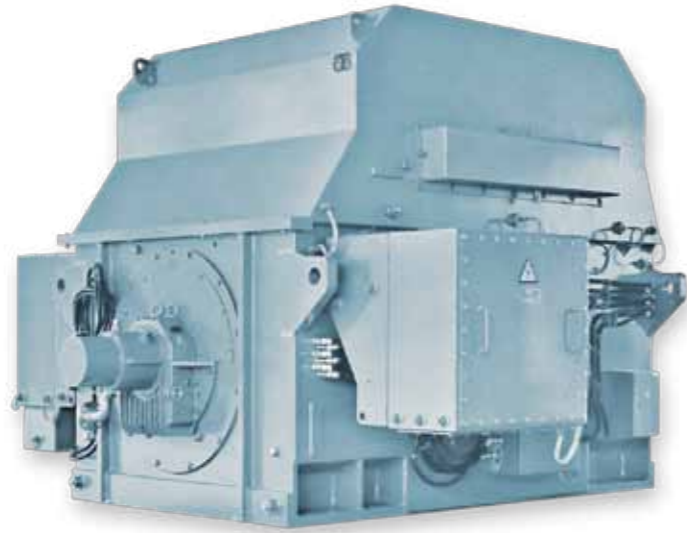
STEAM TURBINE REPLACEMENT SOLUTIONS

FOR COMPRESSION PROCESS OPTIMIZATION

Induction Motors

UP TO 40 MW

MORE POWER IN A SMALLER PACKAGE



COMPACT BUT MIGHTY

GE's induction machines provide the highest power density in their class. What's more, the innovative compact frame upgrade to our well-established legacy motor line doesn't compromise on efficiency or reliability.

WHEN SPACE MATTERS MOST

With a lower frame size than conventional induction motors, this new and compact design translates to space savings and lower weight. This is essential especially for onshore and

offshore applications where space is at a premium and when platforms require reduced weight motors

HELPING TO MAXIMIZE CUSTOMER OUTCOMES

- Reduce operating expenses with longer durability and lower vibration
- Cut capital expenditure with lighter machines that require fewer foundations and associated costs
- Lower energy consumption from machines that are also safer

	RATINGS
Frame Size	560 to 2,000
Poles	2 to 30+
Frequency	50 Hz, 60 Hz, or VFD
Cooling	TEAAC, TEWAC, WPII, TEPV
Power	Up to 40 MW
Client Network Voltage	690 to 15,000 V

KEY FEATURES & BENEFITS

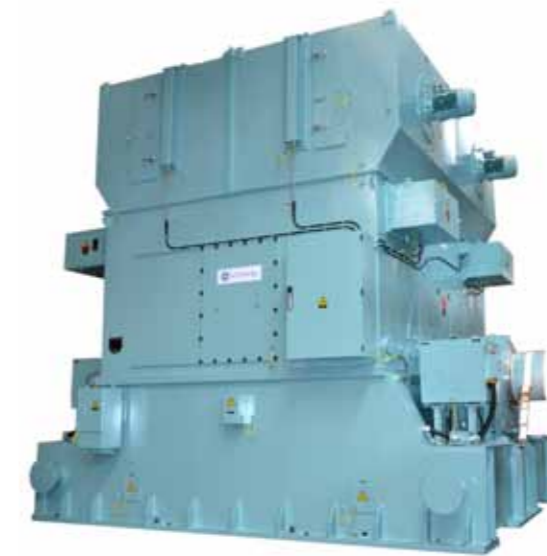
- World-class compact design
- High efficiency
- Low noise
- Reduced weight
- Proven design with innovative components
- State-of-the-art manufacturing equipment
- Test facility up to 40 MW (upon request)
- ATEX/IEC/IECex Protection

DRIVEN MACHINES: Reciprocating compressors, centrifugal compressors, pumps, blowers, fans, extruders

Low Speed Motors

INDUCTION AND SYNCHRONOUS, UP TO 40 MW

LOW WEIGHT & INERTIA ADVANTAGES



EXTENSIVE EXPERIENCE IN MARINE AND OIL & GAS APPLICATIONS

GE's large low speed motors offer lower weight and inertia advantages.

Requiring little maintenance, induction motors can be used in almost all applications requiring high reliability and robust performance.

Marine induction motors are available as vertically-mounted and horizontally-mounted to meet all applications requirements.

PTO/PTI induction generators are available using the same technical platform.

	RATINGS
Frame Size	Up to 2,000
Poles	8 to 36
Frequency	50 or 60 Hz, or VFD
Cooling	TEWAC, TEAAC, TEPV
Power	Up to 40 MW
Rotor Type	Laminated squirrel cage induction, cylindrical or salient poles synchronous

KEY FEATURES & BENEFITS

- Smooth start-up capability: low starting current machines available
- Improved performance/reduced operating expense: power factor correction capabilities
- Reduced maintenance requirements: integrated brushless excitation system
- High reliability: robust brushless components
- High efficiency: enhanced design
- Improved electrical system reliability: reduced torque pulsations for non-steady loads

DRIVEN MACHINES: Reciprocating compressors, fans, extruders, propulsion, marine

High Speed Synchronous Motors

UP TO 100 MW/1,800 RPM

FOR HIGH EFFICIENCY & RELIABILITY



GE offers a full range of horizontal and vertical synchronous motors, ranging from direct-drive high torque density motors to turbo-type motors for compressor applications.

Synchronous motors are utilized for many applications across a broad range of industries.

Because of the high efficiency and controllable power factor of the design, utility costs (and CO² emissions) are minimal.

We can rapidly adapt our standard product platforms to cater for many applications or any purposed starting methods including fixed and variable speed drive.

	RATINGS
Frame Size	900 - 1,600
Poles	4 / 6
Frequency	50 or 60 Hz, or VFD
Cooling	TEWAC, TEAAC, TEPV
Power	Up to 100 MW
Rotor Type	Salient pole rotors (laminated and solid pole dependent upon starting requirements or duty cycle)

KEY FEATURES & BENEFITS

- Easy access for routine maintenance
- High quality design: all rotors are carefully balanced to comply with standards requirements
- High efficiency: increased operating cost savings
- Low starting current: provides better overall starting capability, which reduces the starting equipment cost
- Leading power factor: reduced utility penalties associated with lagging power factor
- Improved electrical system reliability

DRIVEN MACHINES: Compressors, centrifugal compressors, pumps, blowers, fans, extruders

High Speed Induction Motors

STAND-ALONE OR INTEGRATED, UP TO 20 MW/18,000 RPM

SIMPLY MORE RELIABLE



COMPACT & SIMPLE

- Compact machine with easy installation.
- Leaner, low-maintenance motor that delivers extended maintenance periods and longer periods of uninterrupted operation. Delivering 5+ years of operation.

INCREASED SYSTEM EFFICIENCY

- Increased operational flexibility and efficiency
- Up to 98.1% operational efficiency
- Opex savings when combined with VSI drive (~+1.25%* increased overall system efficiency... lower power consumption)

	RATINGS
Frame Size	450 to 800
Poles	2
Speed	6,000 to 18,000 rpm
Cooling	TEWAC, TEAAC, TEPV
Power	Up to 20 MW
Rotor Type	Laminated squirrel cage induction

KEY FEATURES & BENEFITS

- Lower OPEX
- Easy installation
- Easy maintenance
- More efficient speed ranges
- Lower CAPEX
- A smaller motor requiring smaller foundations
- Greater availability
- Ideal for the typical five year run time of large liquefaction units
- ATEX/IEC/IECex Protection

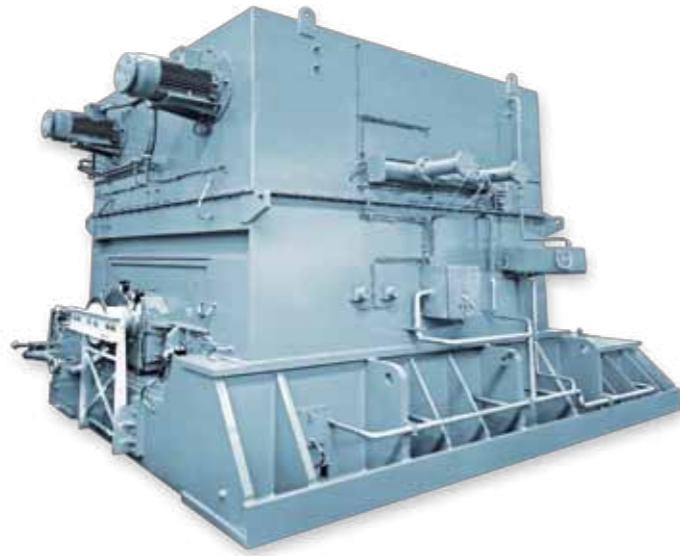
DRIVEN MACHINES: Centrifugal compressors, fans

* estimate from comparison between global system efficiency of N/A project - induction vs synchronous

Two Pole Turbo Motors

UP TO 100 MW

RELIABLE & COMPACT



DELIVERING GREATER RELIABILITY AND EFFICIENCY

GE has been setting the standard in manufacturing rotating machines for over 125 years, delivering innovative power solutions to the world. Motors are designed and manufactured to operate efficiently and reliably in challenging applications and severe environments where reliability and ease of maintenance is critical.

GE's 2-pole turbo motors offer high flexibility and high reliability for centrifugal compressor drive. Induction motors with a simpler rotor (parts reduced x 10), can help increase the MTBF period and allows better optimization of the compressor due to the extended speed range.

	RATINGS
Frame Size	900 to 2,000
Poles	2
Speed	3,000 to 7,500 rpm
Cooling	TEWAC, TEAAC, TEPV
Power	Up to 100 MW
Rotor Type	Laminated squirrel cage induction (Synchronous Laminated Pole available)

KEY FEATURES & BENEFITS

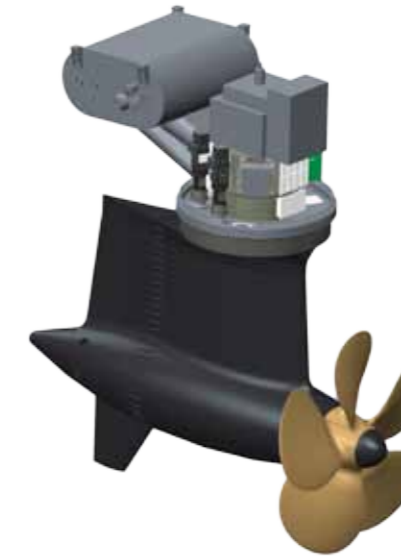
- Reduced OPEX
- Easy installation
- Easy maintenance
- High efficiency
- Reduced CAPEX
- Reduced footprint
- High availability

DRIVEN MACHINES: Centrifugal compressors

Podded Propulsion Motors

SEAJET™ PODS

ENHANCED MAINTAINABILITY AND AVAILABILITY



Dedicated to the marine applications, the SEAJET™ Pods are podded propulsion units. The electric motor is housed in the hull mounted pod and directly connected to the propeller. This allows to liberate cargo space and improve maneuverability/efficiency.

SeaJet™ is developed to enhance maintainability and availability and to meet marine rules and IEC standards. It includes induction motor technology that has demonstrated its robustness through a wide range of experience in naval,

merchant and offshore applications.

Our induction motor is compact and features a bilateral cooling system. The ability of the MV7000 PWM drive to operate at very low frequency allows the motor's pole number to be optimized and a low resistance squirrel cage to be included to increase efficiency and power factor. Reduced unsymmetrical magnetic attraction and shaft deflection make air gap integrity safer than synchronous technology.

	RATINGS
Speed	100 - 200 rpm
Frequency	VFD
Cooling	TEWAC
Power	Up to 25 MW
Rotor Type	Laminated squirrel cage induction or salient pole synchronous

TECHNICAL CAPABILITIES

- Output power from 1.8 to 25 MW
- High thrust capability at high transit speed vessels
- High bollard capability for DP application
- Developed for maximum availability
- Reduced noise and vibration for comfort
- Ice class capability*
- Digital Twin solution

*The ice-class range of SEAJET™ is a joint technology development with AETC Sapphire. SEAJET is a trademark of GE Energy Power Conversion France SAS.

Steam Turbine Replacement Solutions

FOR COMPRESSION PROCESS OPTIMIZATION

Services

POWERING MACHINES UP TO 100 MW

Oil & Gas companies are tightening their grip on costs, and evaluating new ways to improve efficiency. In the downstream segment of the oil and gas industry—refineries, petrochemical and fertilizer plants—compressor trains are an important area for achieving potential process optimization. For processes that don't develop heat or only partially generate steam, like recycle hydrogen, feed gas, and in some instances wet gas applications, or plants located in areas where the power grid is stable, the use of electric motors can represent a better choice vs. steam turbine solutions. The recent advancement of electrification has made it possible and practical for electric motors and drive systems to be an option for powering standalone machines up to 100 MW and integrated ones up to 35 MW.

150+ GE HIGH SPEED SYSTEMS INSTALLED WITH CUMULATED 4.5 MILLION OPERATION HOURS

A smaller footprint and less necessary auxiliaries make it possible to preserve the plant layout in more constrained environments and allow a smooth plant integration, resulting in savings for the associated infrastructure cost. GE's Variable Speed Drive Systems (VSDS) feature a unique combination of Voltage Source Inverter (VSI) and a high-speed motor to help increase reliability and availability of your systems.

KEY COMPONENTS



VARIABLE FREQUENCY DRIVE (VSI)

MV7 range: reliable, scalable and modular

Features

- 1 to 100 MW, up to 13,8 kV
- Standard drive with high performance control
- Power factor >0.95 helps to eliminate reactive power injected to the grid

Benefits

- No torque pulsation on the shaft line
- No harmonics filter needed due to minimum harmonics level on the network
- Reduced noise and vibrations on the motor, allowing extended life cycle and reduced maintenance

HIGH SPEED INDUCTION MOTOR

Efficient, compact, cost-effective

Features

- Variable frequency standalone motor directly coupled to a compressor without gearbox
- 2 pole design, up to 18,000 rpm (highest in class)
- Water to air cooled motor or TEPV motor
- Several rotor diameters
- Magnetic or sleeve bearings
- Copper cage
- Certified Exp according to ATEX
- Shaftless Rotor/ Patented rotor design

Benefits

- No critical speed: reduced vibrations
- Laminated rotor reduces Eddy currents
- IEC 60034 & IEC 60079 compliant
- Proven track records: 120+ high speed motors installed globally



CARING FOR YOUR NEEDS

Our focus on service keeps us actively engaged, both when things are going right, and when they are going wrong. With a comprehensive global network of experts, GE is uniquely positioned to provide the knowledge, experience and skills for your full range of industrial service requirements — help protect assets, maximize productivity, optimize Operation and Maintenance (O&M) cost.

With over 400 field service engineers and operating in more than 160 countries, GE Power Conversion is your global and local partner.

GE offers both on demand services and multi-year service contracts with a range of options from "Keep me running" or "Partnership" up to Asset Performance Management (APM) solutions and digitally enabled production guarantees.

Meeting the needs of your O&M model life cycle, GE provides customized services from daily operation, routine & scheduled maintenance, outages to repair, refurbish and upgrades. With fleet data analytics, GE delivers maintenance optimization, expert onsite and remote 24/7 support, emergency interventions and more.

INSTALLATION & COMMISSIONING

Installing with confidence. Our team of field service engineers are on hand to ensure your assets go into active service functioning efficiently.

INSPECTION & REPAIR

We offer a broad array of generator, excitation and protection relaying inspection and repairs services, supported through our international network of GE specialists and service shops.

Our team of project management experts are available to support and schedule your overhaul requirements, working with you to ensure that you are provided regular project updates and work is completed to your satisfaction on time.

TRAINING PROGRAMS

Through our in-depth training modules we provide our customers with the knowledge and skills to operate and maintain equipment in the field.

Test Capabilities and Certification

MECHANICAL, ELECTRICAL AND THERMAL DESIGN VALIDATION

DO YOU NEED...

- To test your high power machine at full load?
- A full combined test with the entire system (transformer + drive + motor)?
- The tests as per IEC, IEEE, NEMA, API standards?

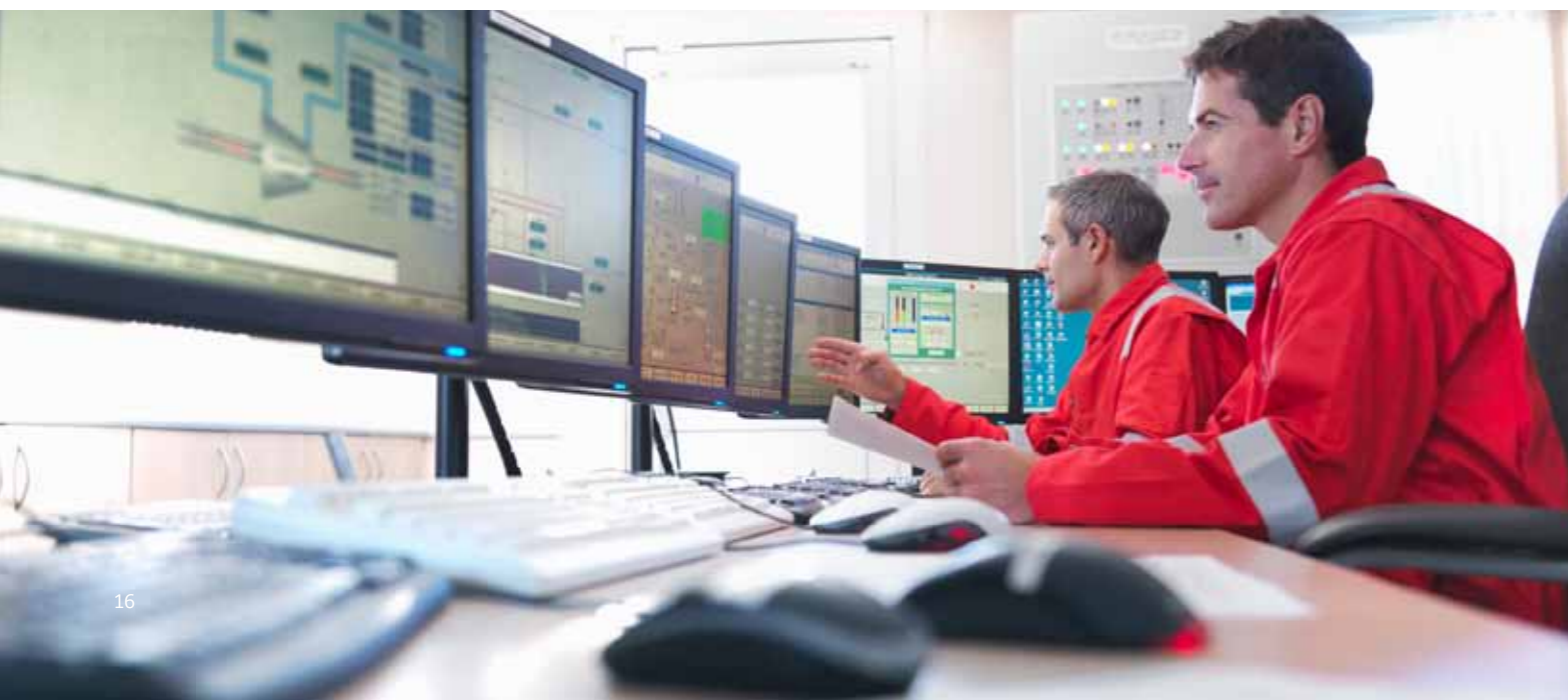
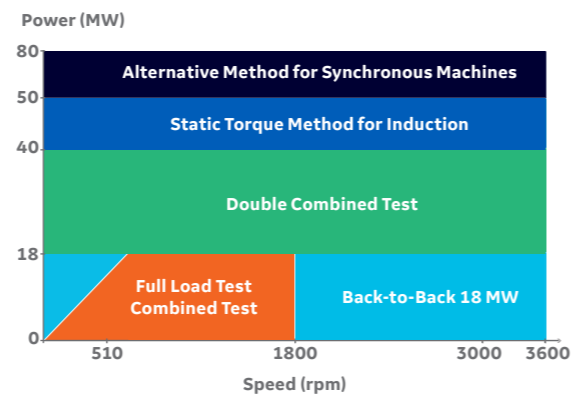


OUR SOLUTION

The first and one of a kind 18 MW test line

- Full load capability up to 18 MW
- Frequency from 5 Hz up to 300 Hz
- 40 MW loading induction machine
- Alternative method on induction forced cooled motors up to 50 MW
- **Full load combined test up to 40 MW** (transformer + drive + motor in back-to-back configuration)

TEST BENCH CAPABILITY CURVE



CERTIFICATIONS

GE Power Conversion is able to provide certification according to the following standards:

- IEC60079 Exp Ex nA
- IEC60034
- Ex d Exe
- API541/546
- Atex (on request)
- IECEx
- Marine class rules
- Ice class
- UL
- Country-specific certifications, like CSA for Canada, BASEEFA for Europe, CU-TR Ex (GOST) for Russia, KOSHA for Korea, INMETRO for Brazil, RETIE for Columbia



Global Installed Base

MORE THAN 30 GW POWER INSTALLED



*based on existing records since approx. 1960



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Center of Excellence for Large Induction
and Synchronous Machines

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Imagination at work

About GE

GE (NYSE: GE) drives the world forward by tackling its biggest challenges: energy, health, transportation—the essentials of modern life. By combining world-class engineering with software and analytics, GE helps the world work more efficiently, reliably, and safely. For more than 125 years, GE has invented the future of industry, and today it leads new paradigms in additive manufacturing, materials science, and data analytics. GE people are global, diverse and dedicated, operating with the highest integrity and passion to fulfill GE's mission and deliver for our customers.

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