Module Solutions
Plug & play power-generation and compression solutions to increase efficiency, reliability and power
Customized design
Optimized configuration of gas compression or power generation equipment and auxiliaries, 100% tailored to customer needs

Integrated assembly
A fully transportable single package available with a dedicated control room installed – ready for single lift or roll on/off

Complete testing
Fully engineered and tested solution designed to minimize risk during the installation phase and enable cycle time reduction

Continuous evolution of proven technologies and innovative processes

1980 Buchan Field
Gas lift

1990-2008
Brazilian Modules
Campos Basin system: PG & EMC modules assembled in Brazil
There are three equally important parts to delivering truly successful modular solutions. First, is the cross-functional engineering expertise to design them using the most advanced technologies available. Second, is the capacity and project management strength to assemble them. Finally, is the crucial ability to test them and ensure they will perform as designed.

GE Oil & Gas has been systematically evolving the modular approach to turbomachinery design since 1985. In that time, we have supplied over 40 pre-assembled power generation and compression modules, customized to meet the specific needs of their increasingly challenging projects around the world.

Between December 2012 and the end of 2013, we will deliver seven of the industry’s most advanced modules ever, five for Australia and two for the North Sea. And we have the capacity to produce more.

We continually invest significant resources in materials, aerodynamics and every other conceivable area – including perhaps the most important one of testing and qualification. We also work closely with key industry-leading clients to ensure that our direction is always true to their needs and where the industry overall is moving.

As a result, GE’s latest modular solutions make the difference between ‘gathering acceptable parts’ and ‘creating an exceptional whole’.

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**Kashagan**
The highest pressure compressor ever built

**Gorgon**
5 x MS9001E GTG modules fully tested
To help Petrobras develop the 8 billion barrels of oil in the Bay of Santos, our solution went far beyond the usual capabilities of our own facilities in Italy. We worked closely with Petrobras and local contractors to design, build and operate a world-class assembly yard in Brazil, developing the local workforce and infrastructure in keeping with the Petrobras vision.

We began in 2004 with two compression modules for the P51 floating production unit (FPU) to be deployed in the deepwater Marlim Sul Field. As progress continued, we simultaneously built two larger compression trains for P52 and two power-generation modules for P54—so that there were six modules under parallel construction using local contractors for steel work, fabrication, engineering and other activities. In 2010, we delivered two compression modules for the P56 FPU.

For all these modules, core equipment (motor-compressor units and turbogenerator trains) was manufactured and tested at the GE Oil & Gas facilities in Massa, Italy and shipped to Brazil for local assembly and construction.

**Kashagan gas compression system**
- 2 full process floating modules
- 820 bar compression system
- Zero leakage technology for 33% H₂S
- 95 x 16 x 25 m each barge
- 4,000 tons each barge
- 19,757 welded joints, 150 km of wires, 7 km of piping

With 18% H₂S and pressures of 760 bar, Kashagan is the most advanced project of its kind. The modular gas compression system we designed for it is the highest-pressure re-injection train ever built—capable of 820 bar and 33% H₂S.

The two trains were mounted on barges specially designed for transport along the winding Volga canal system. For improved maneuverability and installation, our designs were about 500 tons lighter than other existing barges for similar operations. To pass under many bridges and other obstacles during transport, all topside structures above 36 ft were dismantled at our yard in La Spezia and reassembled at the Caspian yard.

The barges then went 60 km into the Caspian Sea in depths of just 3 m—each one carrying a full 32-MW/820-bar compression island. Although our Kashagan barges are commonly referred to as ‘floating systems’, they are actually suspended 69 ft (15 m) above the water to avoid damage by ice flow, heavy currents and storms.
Driven by design

Modern oil and gas operations must respond to evolving resource compositions and extreme operating conditions. They must adapt to increasingly diverse fluid mixtures and processes, expand their reach into more remote and demanding environments, and continually incorporate new technologies for increased efficiency and performance.

Our approach provides customers with the invaluable advantage of total simplification and the potential to reduce site costs and cycle time by as much as 30%. With extensive in-house design, engineering and manufacturing capabilities for all major rotating equipment, we create the most efficient solutions tailored to meet all the unique weight, space, power distribution and performance requirements of each project. All engineering, design, project management, installation and maintenance are part of the package.

GE modules deliver impressive power and compression capabilities in remarkably compact configurations. Individually proven in the industry’s most extreme conditions, all core equipment is seamlessly integrated with relevant auxiliary systems. The final engineered solution is fully tested, connected and wired before delivery. Any necessary third-party suppliers have already been rigorously screened and qualified to the highest quality standards. Their balance-of-plant equipment is integrated by our engineers at the system-design stage.

30% ↓ site costs & cycle time

Analysis & design to ensure that the concept can be executed
- Erection and testing static analysis
- Land and sea transport analysis
- Lifting, jacking and skidding analysis
- In-service static analysis
- Blast analysis
- Modal and dynamic response analysis
- Fatigue analysis
- Design for operability and maintenance
- Space management — interference checks
- Robust design review process (30%-60%-90%)
- Construction studies

Single-source engineered solutions
- Fully integrated engineering approach at the system level
- Conceptual and process design, instrumentation and control design, electrical systems design
- 3D modeling of piping and structures
- Materials management fully integrated with 3D modeling
- Structural dynamic analysis of modules and foundation
- Design for transportation, including fatigue analysis
- Maximized prefabrication enables far less on-site installation, construction and testing
- Comprehensive testing, commissioning and start-up services
- Effective management and coordination at every phase of the project
Assembly

GE builds true ‘plug & play’ solutions – accelerating production, minimizing infield construction requirements and ensuring each unit’s suitability to the project’s final physical site and ongoing operating requirements. All mechanical, electrical and instrumentation work is managed by experienced GE personnel.

We can also design and transport module components for construction localized at the customer’s site, if that is preferred. Our operations team can still provide all project management, engineering, quality, EHS and procurement functions. We regularly provide this experience at integration yards around the world, partnering with local companies to ensure GE’s high quality standards are applied to each project.

Environmental Health & Safety

GE has a fully developed EHS program designed to meet the most stringent regulations of all regions worldwide. Since our modules are destined for a wide range of sites with equally varying regulations and environments, all their needs are woven into our integrated approach to every project. For example, we developed innovative quarantine procedures to address the highly sensitive environmental needs of Gorgon’s Barrow Island nature reserve. This process can now be replicated and adapted to other environmentally challenging projects in the future.

Dedicated customer support

Each module project is directed by a team of experienced Site Operation Leaders who support each customer from design through to commercial operation. This continuity ensures safe and efficient execution of every project, with smooth transitions and open communication from beginning to end.

Avenza at a glance

Avenza is strategically located on Italy’s west coast, close to our Massa plant and even closer to the Marina di Carrara port. From there, modules are easily readied for international shipping to the Atlantic through the Strait of Gibraltar, to the Indian Ocean through the Suez Canal and Red Sea, or eastward through the various canal systems.

- 140,000 m² (36 acres) for construction, commissioning and testing
- 30,000 m² (7 acres) of dedicated storage
- 4,000 tons load-out capacity
In addition to advanced module design and integrated assembly, our rigorous testing approach is what gives customers the confidence that their modules will deliver ongoing reliability and performance to achieve operating goals year after year.

Our Avenza facility includes the technologies and capacity to test completely assembled modules of every size and configuration that we build. This is a unique advantage – no other facility in Europe has full module testing capabilities.

We employ the most advanced techniques and seasoned professionals – tried and true methods are combined with emerging technologies to enhance testing capabilities. Our processes are completely instrumented and furnished with real-time data-acquisition systems and integrated analysis tools to provide a complete picture of equipment performance, even while the test is still in progress.

Full package testing
- Core turbocompression equipment
- Piping
- Wiring
- Control systems
- Auxiliary systems
• Maximum module test footprint: 60 x 22 m
• Turbine fuel gas flow rate: 40,000 SCM/hour
Gas compression and power generation modules can range from simple configurations to large modules that include both turbo compression and gas processing equipment in the same prefabricated structure. Where there are significant transportation and logistic constraints, large modules can be divided into different preassembled components that are easily interconnected at the final installation site. Modules can be designed for transport by single-lift or roll on–roll off (RO-RO) skidding – depending on the project’s specific requirements.

Avenza: strategically located for global shipping

- 2 km from GE’s Massa plant
- 1.5 km from Marina di Carrara port
Containing about 40 trillion cubic feet of gas and including the world's largest carbon capture and sequestration project, Gorgon is the largest single-resource natural gas venture in Australian history and one of the largest natural gas projects in the world.

GE Oil & Gas is supplying five fully assembled and tested 126-MW power generation modules to enable Gorgon's LNG output of 15 MTPA. The first of these left our Avenza yard on October 3, 2012 and was shipped from the nearby Italian port of Marina di Carrara. The other four modules will all be delivered before the end of 2013.

The installation site is on Australia's Barrow Island, a Class A Nature Reserve, where the Gorgon facilities occupy just 1.3% of the island's uncleared land mass. Our Quarantine Management System was recognized as "First class" during the "Pursuing Excellence in Quarantine" conference in Singapore.

**Gorgon power generation modules**
- 5 modules @ 126 MW each
- Frame 9 gas turbine driver
- 50 x 22 x 27 m each module
- 2,300 tons each module

At depths of about 600 m in the North Sea, the Laggan and Tormore fields are the UK's deepest offshore production wells. They will be developed using a 140-km subsea tie-back and control umbilical, connecting to a new gas processing plant being built at Sullom Voe on the Shetland Islands. An estimated 500 million standard cubic feet per day (MMscfd) of gas will be separated at the plant and compressed for export and delivery to the UK National Grid.

Plant design and construction is being undertaken with high degrees of care and efficiency, since the Shetlands are home to protected species. Equipment must also be resilient to the extreme site conditions, unprotected from the harsh salty Atlantic—including 18-m average wave heights and high winds.

Benefits of our module designs include long-term reliability and availability to best manage the lifecycle maintenance challenges common with such remote sites. The high pressure (165 barg) export pipeline required careful core equipment selection and configuration. Each module is a complete compression train with a compact and powerful PGT25+ gas turbine driving two BCL centrifugal compressors.

The three fully assembled and tested modules—plus external auxiliaries and waste heat recovery systems—were shipped in January 2013.

**Laggan-Tormore compression modules**
- 3 modules, each including a PGT25+ gas turbine driver, gear box, BCL454 and BCL405A compressors, external auxiliaries and waste heat recovery unit
- 34 x 8 x 17 m each module
- 362 tons each module
The information contained herein is general in nature and is not intended for specific construction, installation or application purposes. GE reserves the right to make changes in specifications or add improvements at any time without notice or obligation.

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