Yokogawa
LNG Supply Chain

Ichthys LNG Production Facilities
Photo courtesy of INPEX CORPORATION

A Trusted Partner With Proven Experience

Yokogawa's commitment to innovation in LNG projects worldwide dates back to the 1970s.
Yokogawa keeps encompassing leading edge technology for the LNG industry to maximize productivity.

Providing the latest technology to the world's largest LNG terminals since 1973

The Tokyo Gas Sodegaura LNG terminal started operations in 1973 and is one of the world's largest LNG terminals, with a total amount of 4,509 million tons received per year (as of 2018), a storage capacity of 1.35million kℓ and a vaporization capacity 1,455t/h. Yokogawa has since gone on to migrate the DDC to a Distributed Control System (DCS), changing panel operations to a centralized operation.

Never disturbing plant operations

The challenge of control system migration is to update systems without interrupting production. At LNG terminals, the temperature inside the tank has to be maintained at a constant -162℃ to avoid generating boil-off gas (BOG). Yokogawa has more than 40 years experience providing customers with hot cutover.

Supporting Plant Integrity

The Sodegaura Terminal is currently divided into two areas (East and West), each with its own receiving berth, electrical, and supply system. This double-plant setup enables the two areas to back each other up, assuring a high degree of reliability. Yokogawa supplies integrated control and safety systems to the two independent areas, and achieve the centralized operation of both areas, improving operation efficiency and integrity of the plant.

2022
CENTUM VP

CENTUM CS 3000
2006

Hot Cutover

1988   CENTUM V

Over 40year's LNG experience

Upgrade

1973   LNG terminal Sodegaura started

Sodegaura LNG receiving terminal
Photo courtesy of TOKYO GAS Co., Ltd.

Explore the Yokogawa capability in LNG industry

Yokogawa has long standing expertise providing solutions to the LNG industry

License to Operate

HSE
Regulation
Security

Lower TCO

Advanced Process Control
Modular Procedural Automation
Operator training

Plant Uptime

High Availability
Alarm Management
Predictive Maintenance

Digital Transformation

Digital Twin
Performance Benchmark
Optimization

Regasification
54 Terminals

Headquarters

Liquefaction
76 Trains

FLNG

Regasification

Transportation
97 Vessels

Gas to Power

LNG Carrier

FSRU

LNG Carrier

Offshore Platform

Yokogawa has a long history and wide variety of solutions to the LNG supply chain

FSRP

* FLNG : Floating LNG
* FSRP : Floating Storage & Regasification & Power-Generation
* FSRU: Floating Storage Regasification Unit

As of May 2022

Liquefaction Experience

Yokogawa has installed 76 trains globally with a wide capability of products and solutions from sensors to modelling

Dehydration and mercury removal

- Drier sequence control
- Regeneration gas compressor control

Liquefaction

- Feed Gas Pressure/flow Control
- MR balance control
- Pre-cool refrigerant compressor and flow/temp control
- MR refrigerant flow/temp controls
- End Flash and pressure control
- LNG Rundown and Production control
- Anti-Surge Control

Acid Gas removal

- Feed gas KO Drum pressure control
- Absorber Bottom Level/Flow control
- Absorber inlet lean amine flow control
- Pressure monitoring
- Temperature monitoring
- Treated gas quality monitoring
- Amine regeneration control
- Sulphur recovery unit control

NGL Recovery/Fractionations

- Feed Gas Pressure Control
- Bottom level and Disch. Flow control
- Reflux Flow control
- Reboiler temp control

LNG Storage Loading

- Tank monitoring
- Loading sequence
- Circulation control for loading lines
- BOG compressor

Key technology for your benefit

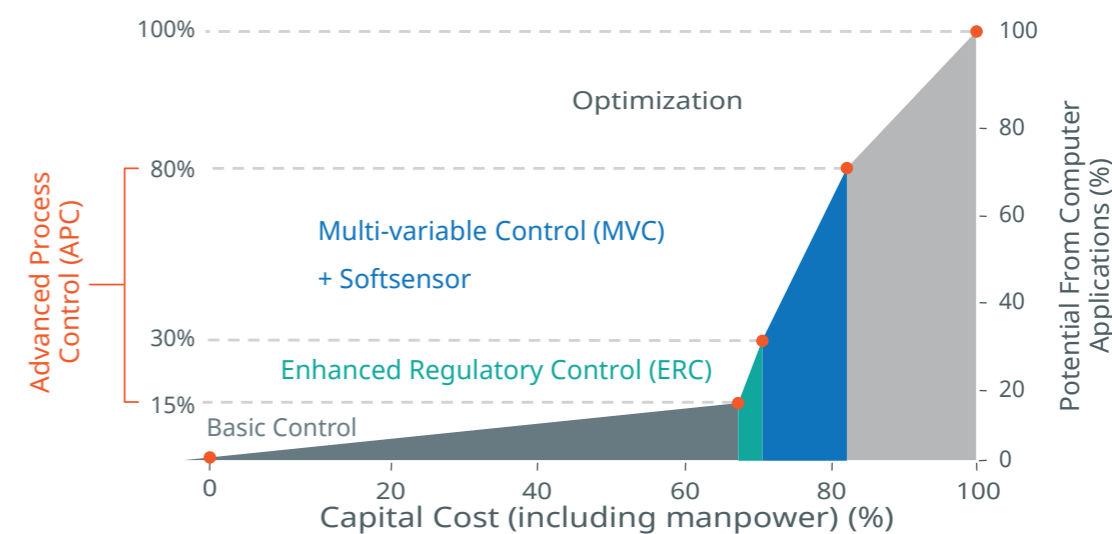### Faster Start-up Contributes to Quick Production Delivery

Automated cool down of the Main Cryogenic Heat Exchanger (MCHE) using Modular Procedural Automation (MPA) shortens start-up time and avoids equipment damage

The MCHE is the key component of an LNG plant. It consists of large bundles of tubes in an aluminum shell. At start-up, the MCHE has to be cooled down from ambient temperature to around minus 160℃ where the natural gas is liquefied.
Controlling the temperature of the MCHE according to the ideal temperature curve is challenging for the operator. Several valves need to be controlled at the same time while the process response changes as the cool-down progresses. Poor operation may result in exceeding the maximum allowable temperature change over time, which can damage the MCHE due to thermal expansion and contraction. However, slow cooling will delay the start of production. To avoid these risks, highly reliable and efficient automated operation is required. Yokogawa's Modular Procedural Automation (MPA) employs the best operators experience, process expertise, analyses of the existing procedure and historical data. Automated cool down is enabled as if an experienced operator were controlling the plant. The start-up time is shortened without damaging MCHE.

Next-generation Advanced Process Control maximizes throughput

Platform for advanced control and estimation optimizes production while ensuring stable control

The liquefaction process is complex because it is affected by factors, such as gas composition, ambient temperature, separator level and compressor performance. To achieve steady process control, those variables need to be controlled by Advanced Process Control (APC). Yokogawa has been providing APC licenses and consulting for more than 20 years. Based on our expertise in process automation, Yokogawa's next-generation of APC, called Platform for Advanced Control and Estimation, provides process optimization to maximize throughput while ensuring steady process control.

Chart axes: Advanced Process Control (APC); Capital Cost (including manpower) (%); Potential From Computer Applications (%). Regions labeled: Basic Control, Enhanced Regulatory Control (ERC), Multi-variable Control (MVC) + Softsensor, Optimization.

Transportation Experience

Yokogawa has installed 97 vessels with a wide capability of products and solutions from sensors to modelling

Power Management System

- Control of circuit breakers and monitoring
- Load Dependent Start/Stop
- Load Sharing
- Frequency Control
- Blocking of Heavy Consumers
- Load Reduction to Propulsion Drives
- Load Shedding (preferential trip)
- Automatic restarting after blackout
- Generator Control & Monitoring
- Propulsion Drive Interface
- Emergency Switchboard Interface

Machinery System

- Fuel Oil & Fuel Gas System
- Personnel Alarm System
- Extension Alarm System
- Reduction Gear System
- Fresh, Cooling, Feed Water System
- Bilge Level Monitoring System
- Air Ventilation and Fans
- Compressed Air System
- Lube Oil System
- Machinery Miscellaneous

Gas Management System & Fuel Gas Supply System

- Tank Pressure Control
- Fuel Mode Control
- GCU Control
- Fuel Gas Pressure Control
- Forcing Vaporizer Control
- N2 Purge Sequence
- Vent Control
- Master Gas Valve Control

Ballast System

- Ballast Pumps & Valves
- Automatic Ballast/Deballast Control
- Automatic Ballast Water Exchange

Regulation

- Sox monitoring for new IMO agreement

Vapor Handling System

- Fuel Gas Compressor
- Vapor Return Compressor
- Forcing Vaporizer
- LNG Vaporizer
- Gas heater

LNG Carrier

Cargo Containment System

- Temperature Monitoring
- Pressure Monitoring
- Level Monitoring

Cargo Control System

- Cargo Pumps Control
- Stripping/Spray Pumps Control
- Emergency Cargo Pumps
- Cargo Operation (Loading/Unloading)

Cargo ESDS

- ESD for Cargo Containment System
- Cargo Tank Protection System
- Fuel Gas Master Valve
- Ship/Shore Communication System

Re-liquefaction System

- Re-liquefaction Compander Control System
- Heat Exchange Control

Key technology for your benefit

Prepare for unexpected conditions
Dynamic simulator trains the operator to prepare for the unsteady operations

Yokogawa is driving the advanced usage of the dynamic simulator which can be used for multiple purpose throughout the lifetime of the LNG carrier. The dynamic simulator is ideal for operator training, and it can be a useful tool to validate the system design by allowing rigorous system testing under all operating condition.
By combining the ICSS test function with the process dynamic simulator, process reaction can be predicted.

Process Modeling

ICSS
Virtual Test Function

Simulator
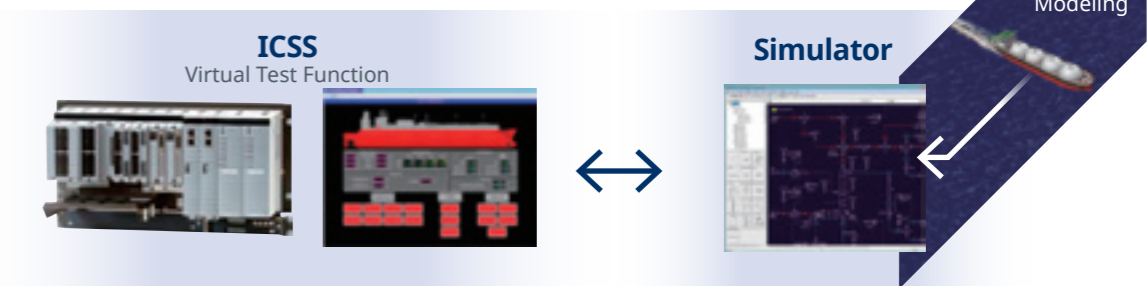
Keep vessels safe anywhere they are located
Real-Time Fleet Monitoring System contributes to integrated monitoring of your fleet

Yokogawa provides a real-time base fleet monitoring system with secure data transmission. Real-time data contributes to monitor fleet conditions without delay and fully customizable KPI dashboard assists swift decision-making in fleet management.
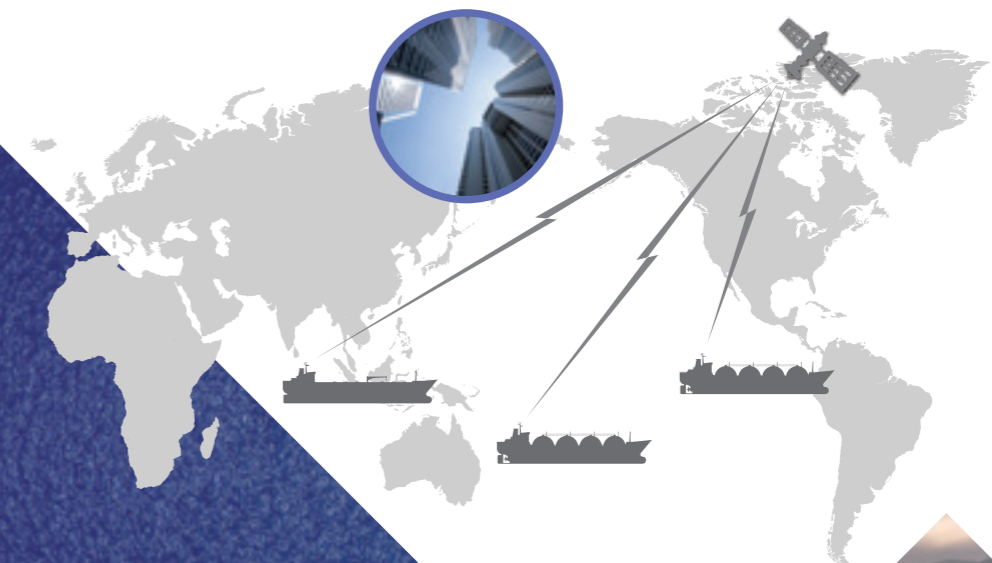
Regasification Experience

Yokogawa has installed 54 terminals globally with a wide capability of products and solutions from sensors to modelling

LNG Unloading

- Recirculation Flow Control
- Return Gas Temperature and Pressure Control
- LNG Drain Drum Level Control
- Uploading lineup control
- Berth Monitoring System
- Unloading Arms Packaged System Function

HP Send-out Pump

- Pump Start/Stop Control
- Discharge Control
- Kickback Flow Control

Send Out Control

- Send out Header Pressure Control
- Send Out Gas Calorie Control
- Gas Odorization Flow Control

BOG Compressor/ Recondenser

- Compressor Start/Stop Control
- Suction Drum Temperature Control
- Kickback Flow Control
- Recondenser Control
- Packaged PLC Functions
- Capacity Control

Open Rack Vaporizer (ORV)

- LNG Flow Control
- Seawater Flow Control
- Seawater Pump Control
- Start/Shutdown Sequence Control

Submerged Combustion Vaporizer

- LNG Flow Control
- Packaged System Functions

Fuel Gas and Service Gas

- Fuel Gas Pressure Control
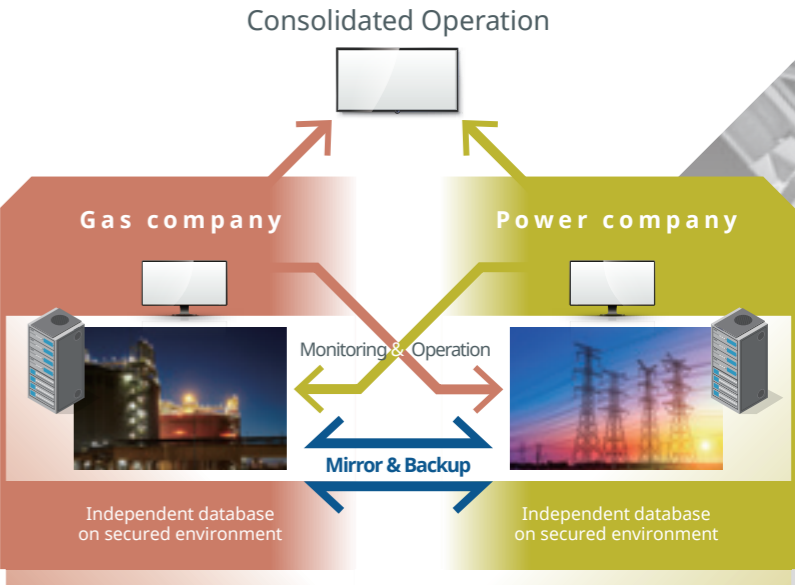- Fuel Gas Heater Control

LNG Tank

- Tank Inlet Mixing Line Valve Control
- Tank Pressure Control
- Level, Temperature, and Density Monitoring
- In-tank Pump (LP Pump)
- Pump Start/Stop Control
- Kickback Flow Control
- Supply Chain Scheduler

Consolidated Gas-to-Power System Increases Operation Efficiency

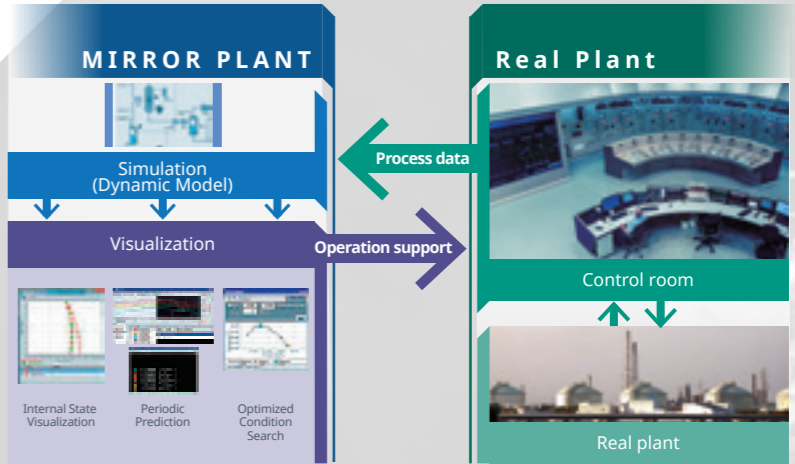**Operation windows with different databases can be cross monitored in each plant**

The two main uses of LNG are power generation and town gas supply. The number of Gas-to-Power projects, in which a gas power plant is constructed in conjunction with an LNG terminal, is increasing in countries with growing power demand. Consolidated operation between the LNG terminal and the power plant is required more since each plant operation affects the other. For example, an unexpected incident at an LNG terminal may cause a significant decrease in the pressure of gas delivery, which can result in a gas turbine trip or parallel-off of generators at a power plant. An unexpected problem with a gas turbine at a power plant may cause excessive gas supply, which forces the LNG terminal to suppress the gas supply. Consolidated operation enables agile operations, such as first cut-out, and efficient balancing of the gas supply and demand at each plant. Yokogawa provides a consolidated operation environment while securing each company's data independently, based on long expertise in power generation and LNG terminal automation.

Consolidated Operation

Gas company

Power company

Monitoring & Operation

Mirror & Backup

Independent database on secured environment

Independent database on secured environment

Operators Take Quick Action to Prevent Alarms

Yokogawa's online simulator MirrorPlant predicts LNG regasification plant behavior

Yokogawa's MirrorPlant dynamically simulates the behavior of a plant by updating the model's parameters using feedback from the real plant. By applying DDR (Dynamic Data Reconciliation) algorithms, a more precise representation of the current state of the process is achieved. MirrorPlant calculates LNG calorific value by using factors such as Boil-Off Gas (BOG) and calculates delivering gas quality (calorific value and odor concentration), and visualizes the results in graphical and trend form.
MirrorPlant forecasts possible alarms by predicting the process behavior of the LNG terminal. Then agile action can be taken according to these predicted behavior changes to ensure stable operations.

MIRROR PLANT

Real Plant

Simulation (Dynamic Model)

Process data

Visualization

Operation support

Control room

Internal State Visualization

Periodic Prediction

Optimized Condition Search

Real plant

Highly Automated and Highly Reliable Systems Ensure a Stable Gas Supply

Yokogawa provides field-proven software and redundant configurations

Advanced terminal unit control (ATUC) is a group of software modules on FCS* developed through Yokogawa's extensive experience working with gas companies. ATUC is specialized for LNG terminal control, optimizing load sharing according to demand changes and achieves immediate control during unexpected conditions. ATUC also enables automated supply volume without the operator's intervention, lowering the load on operators. By implementing ATUC in redundant configuration, continuous supply is ensured in case of unexpected incidents and during maintenance.

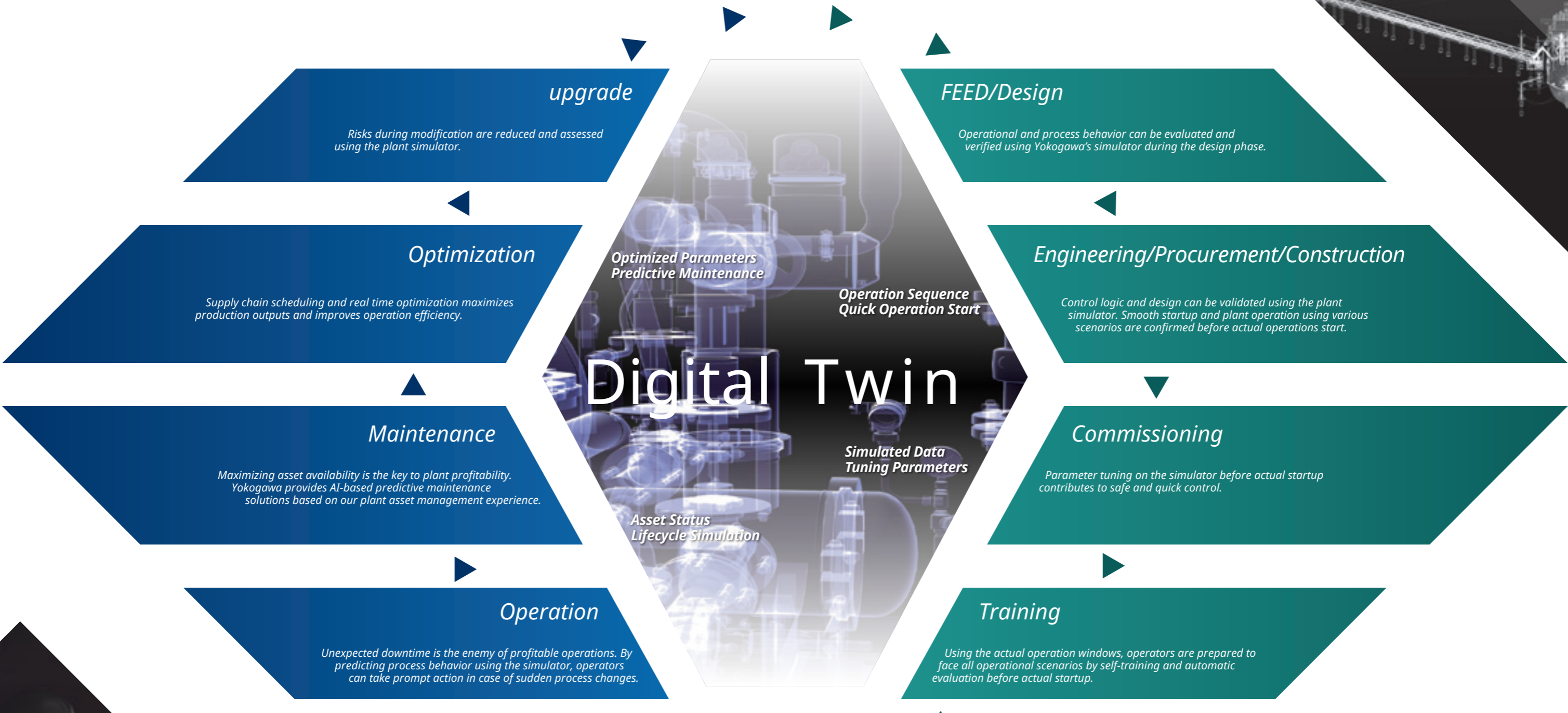*FCS: Field Control Station (control unit of Yokogawa DCS)

Future Path Embracing Digital Technology

As a genuine MAC (Main Automation Contractor), Yokogawa brings digital transformation to LNG plants at each stage of the plant lifecycle

Operational Readiness

Agile Project Execution

Plant startup time is reduced and plant integrity is improved by validating the control logic and setting the tuning parameters using Yokogawa's digital twin technology.
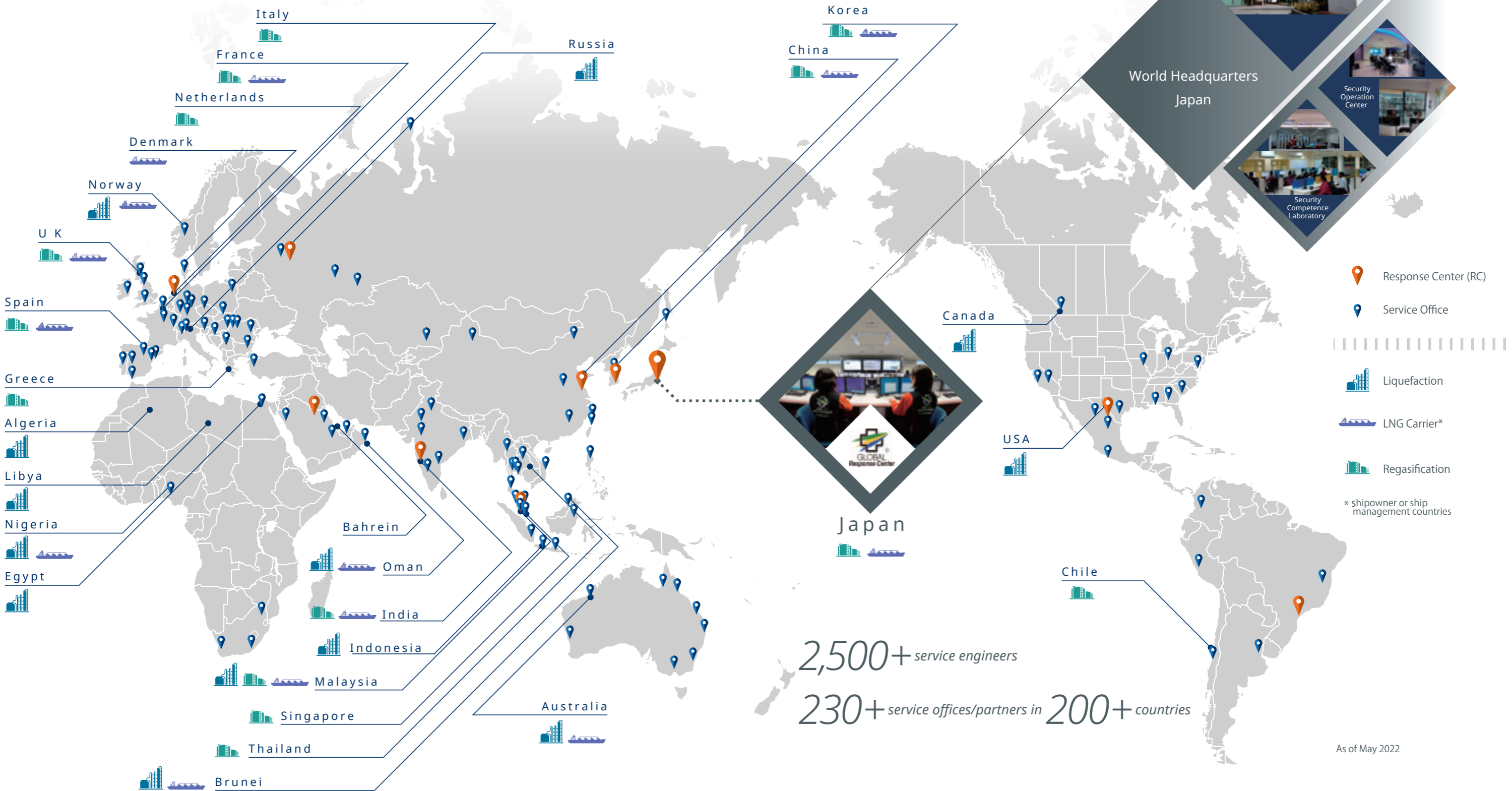
Digital Twin

Optimized Parameters Predictive Maintenance

Operation Sequence Quick Operation Start

Simulated Data Tuning Parameters

Asset Status Lifecycle Simulation

upgrade

Risks during modification are reduced and assessed using the plant simulator.

Optimization

Supply chain scheduling and real time optimization maximizes production outputs and improves operation efficiency.

Maintenance

Maximizing asset availability is the key to plant profitability. Yokogawa provides AI-based predictive maintenance solutions based on our plant asset management experience.

Operation

Unexpected downtime is the enemy of profitable operations. By predicting process behavior using the simulator, operators can take prompt action in case of sudden process changes.

FEED/Design

Operational and process behavior can be evaluated and verified using Yokogawa's simulator during the design phase.

Engineering/Procurement/Construction

Control logic and design can be validated using the plant simulator. Smooth startup and plant operation using various scenarios are confirmed before actual operations start.

Commissioning

Parameter tuning on the simulator before actual startup contributes to safe and quick control.

Training

Using the actual operation windows, operators are prepared to face all operational scenarios by self-training and automatic evaluation before actual startup.

Business Readiness

Profitable Operation and Maintenance

Highly reliable control systems are the basis of plant integrity, however optimization of assets and resources are required to increase business profitability. Yokogawa's digital twin contributes to plant optimization.

LNG Experiences and Global Network

Regional response center

Europe | Russia | Middle East and Africa | India | China | Korea | Asia | North America | South America

Italy
France
Netherlands
Denmark
Norway
U K
Spain
Greece
Algeria
Libya
Nigeria
Egypt

Bahrein
Oman
India
Indonesia
Malaysia
Singapore
Thailand
Brunei

Russia

Korea
China

World Headquarters
Japan

Security Operation Center

Security Competence Laboratory

Response Center (RC)

Service Office

Liquefaction

LNG Carrier*

Regasification

* shipowner or ship management countries

Canada

USA

Chile

Australia

Japan

2,500+ *service engineers*

230+ *service offices/partners in* 200+ *countries*

As of May 2022

OpreX™ Through the comprehensive OpreX portfolio of products, services, and solutions, Yokogawa enables operational excellence across the enterprise.

Visit our website at:

https://www.yokogawa.com/industries/lng-supply-chain/

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