

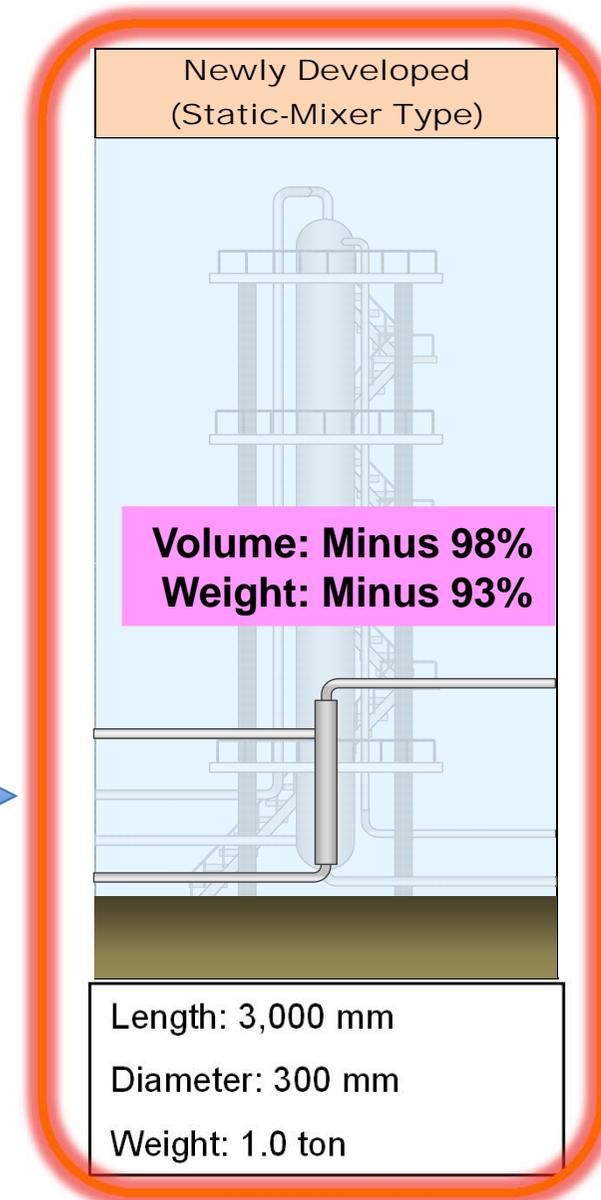
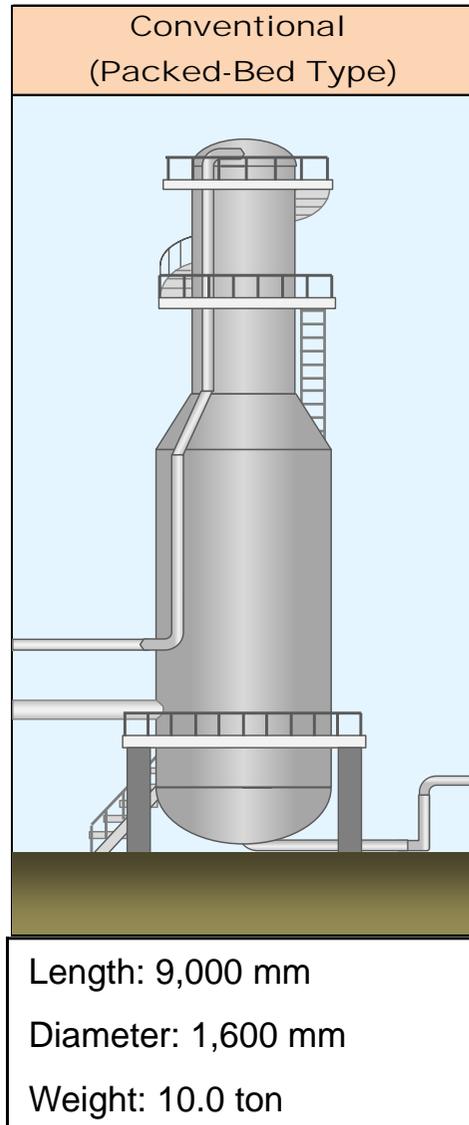
JFE
Engineering
Company Profile

In-line BOG Recondenser

November, 2017

In-line BOG Recondenser

Amazing Size !



Note: Assuming BOG Recondensing Capacity 14 t/h

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The Shocking size !

Newly Developed

Static Mixer Type



Unique and Innovative

This unique and innovative recondensing process, developed by JFE, materializes such a extraordinary small BOG recondenser.

Our proprietary internals convert BOG in very fine bubbles and let them penetrate into subcooled LNG.

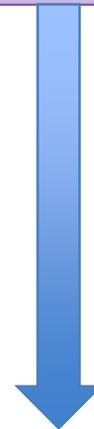


The fine bubbles maximize the surface area of BOG, which accelerates heat transfer between BOG and LNG.



The BOG bubbles are immediately dispersed and recondensed.

The internals also make the LNG flow more turbulent, which enhances the mixture of BOG and LNG.



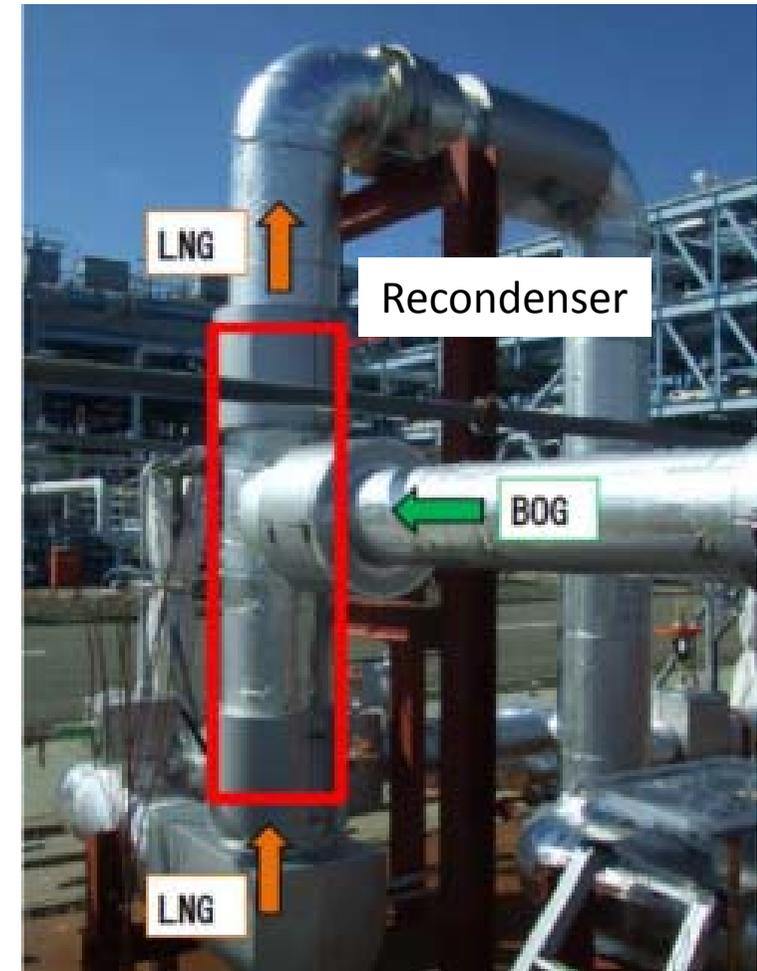
Technology Development

Laboratory Test by water-steam system (2013)

- **Identified the parameters** affecting the recondensing performance
- **Found the best internal design** to maximize the performance
- Created the preliminary design guideline

Pilot Test by LNG-BOG system (2014)

- 1/15 scale test at an existing LNG receiving terminal
- **Conducted numerous tests** to evaluate the risks against safe and stable operation of the whole recondensing system
- Verified the recondensing performance is close to **the theoretical limit**^(*)
- Demonstrated the device is applicable to **the BOG from US shale gas**



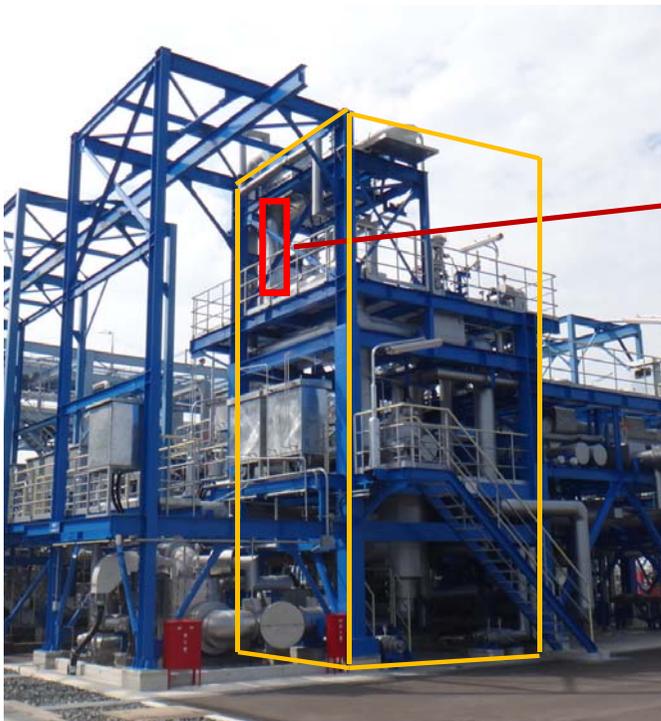
Pilot Plant

(*) Theoretical limit

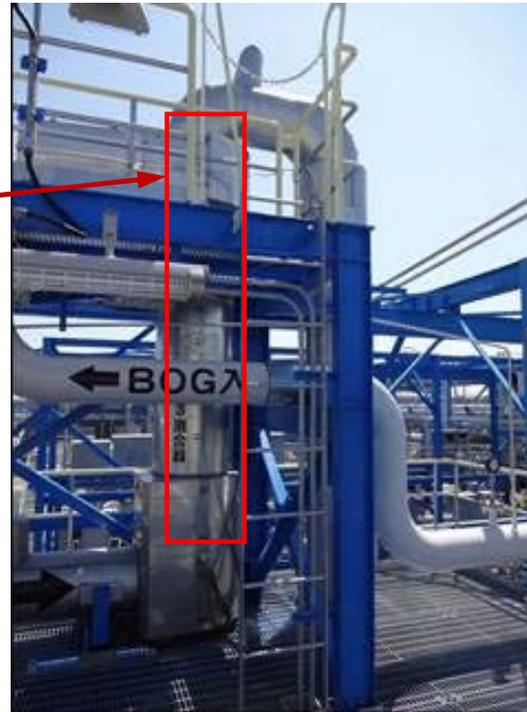
The minimum ratio of LNG/BOG mass flowrate where all BOG can be recondensed completely assuming 100% heat exchange efficiency.

First Commercial Plant

- **Re-verified** the recondensing performance (no issue for scale-up from the 1/15 pilot plant)
- Demonstrated **stable operation** in commercial stage
- Established **the design guideline** (Trade Secret)



Whole BOG Recondensing System



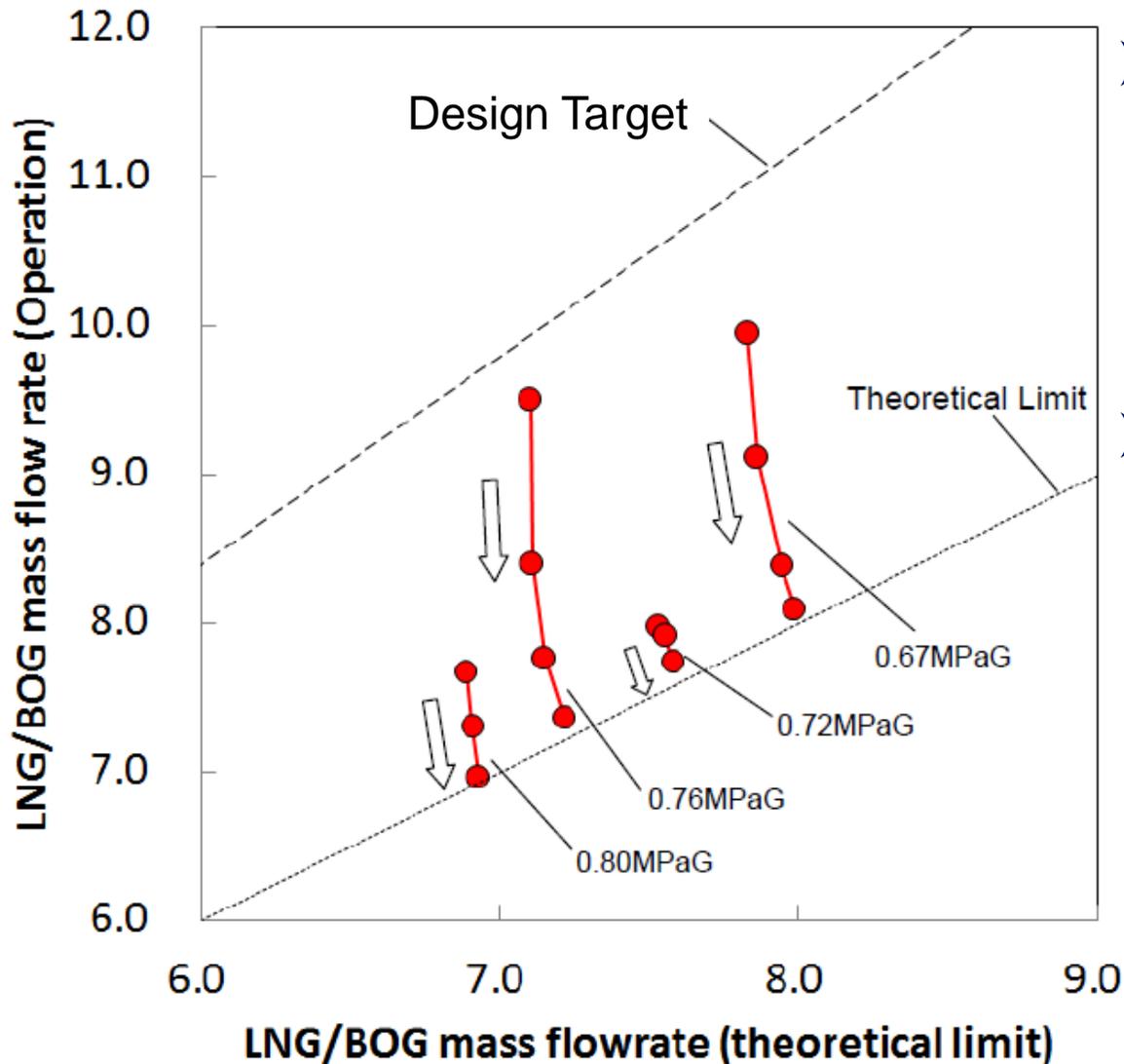
BOG Recondenser

Owner : Toho Gas Co., Ltd.
Location : Chita-Midorihamama,
Aichi, Japan
In operation since April, 2016

Specification

Design Pressure	2.2 MPaG
BOG Flowrate	13t/h at 40°C
LNG Flowrate	155t/h at -154°C

Super Performance



➤ **Challenged the limit**

The recondensing performance is very close to the theoretical limit^(*)

➤ **Minimize Pressure Drop**

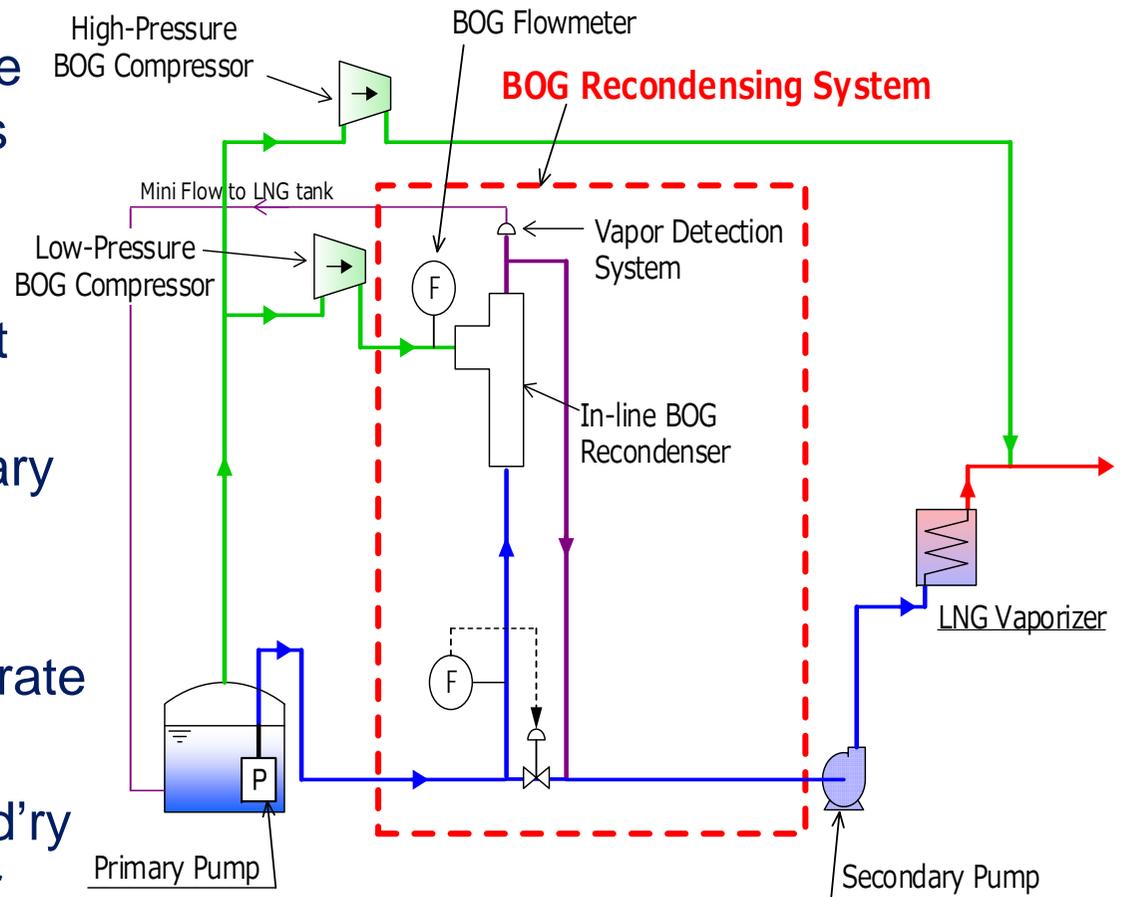
Small pressure drop enhances the utilization of the LNG sensible heat, which boosts the recondensing capacity.

(*) Theoretical limit

The minimum ratio of LNG/BOG mass flowrate where all BOG can be recondensed completely assuming 100% heat exchange efficiency.

Safe Operation with Low Operational Complexity

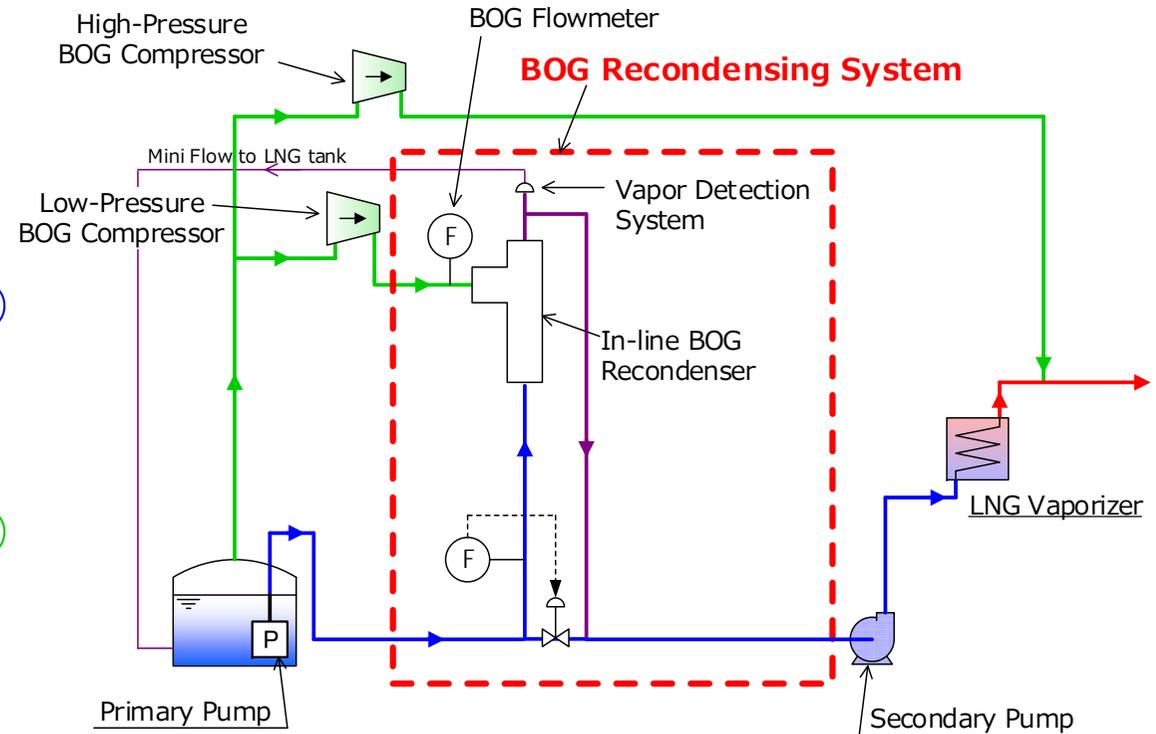
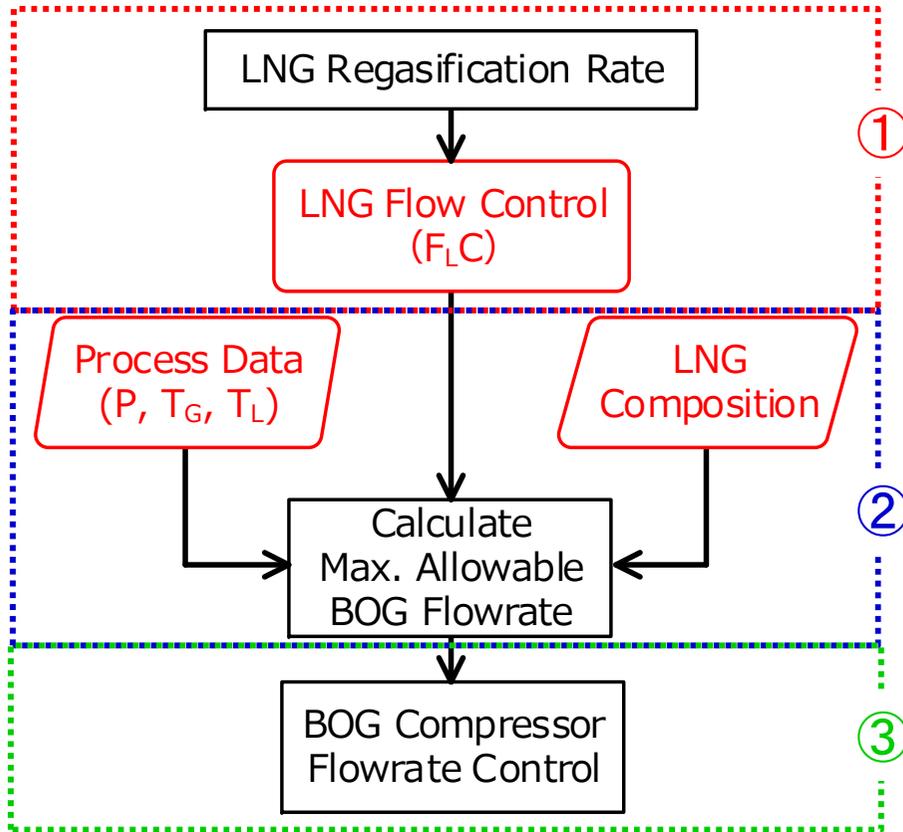
- LNG flowrate to the recondenser is kept constant at a set value. The value is reduced only when the regas rate is lower than the initial set value.
- BOG flow is controlled below its max. allowable flowrate ('MABF') to prevent BOG carry-over at the recondenser. MABF is calculated by JFE's proprietary control system.
- Excess BOG is sent to a pipeline by HP BOG compressor when BOG flowrate is larger than MABF.
- Vapor Detection System stops the 2nd'ry pump when it detects BOG carry-over.



Complex Calculation without Process Simulator

JFE's proprietary control system calculates MABF^(*) without process simulator.

(*) MABF : Max. allowable BOG flowrate

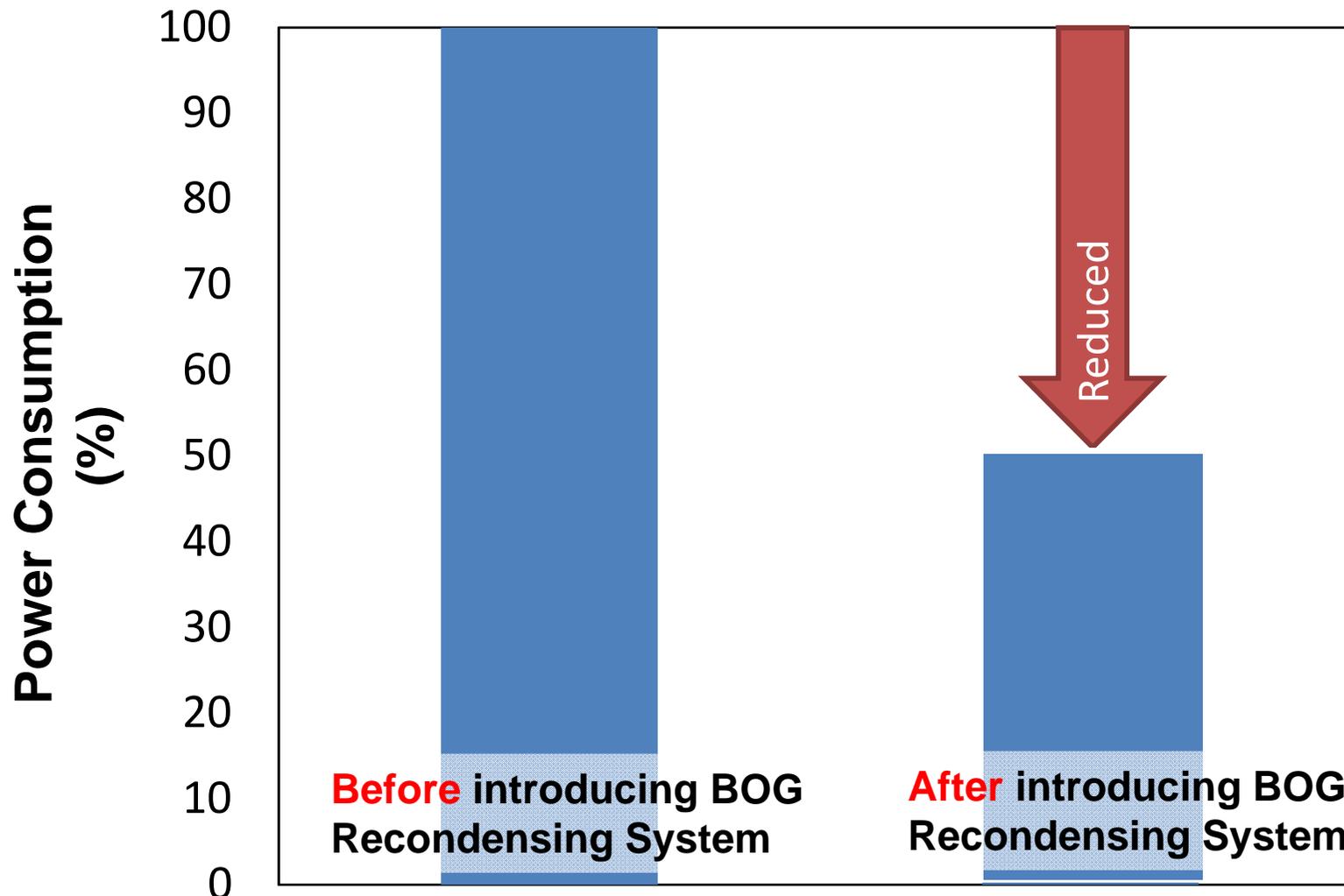


Control Sequence

- ① Adjust LNG flowrate at the recondenser based on the LNG Regasification rate.
- ② Calculate the max. allowable BOG rate from the process data and LNG composition.
- ③ Avoid excessive BOG comes into the recondenser

Significant Reduction of Power Consumption

Achieved **50% reduction** in power consumption at BOG processing system in the first commercial plant



Tiny Mighty

- ***Saving Space, CAPEX and OPEX***
- ***Minimizing pressure drop***
- ***Safe operation with low operational complexity***
- ***Simulating process without a simulator***
- ***Reducing power consumption***

JFE will provide;

- ***In-line BOG Recondenser,***
- ***Control System installed in PLC, and***
- ***Licensed Engineering Package.***
(PFD, P&ID, Control Philosophy, O&M Manual, etc.)

Please contact us for any enquiries.

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