SAKHALIN-1 PROJECT
ENERGY EFFICIENCY IMPROVEMENTS OVERVIEW

EXXON NEFTEGAS LIMITED

2017

Energy Efficiency Improvements Overview

INTRODUCTION

Exxon Neftegas Limited continues to optimize consumption of fuel and energy resources (FER) at its production, office and residential facilities. A key step towards energy use improvement is an energy audit performed in compliance with the following regulations:

- Federal Law #261-FZ dated November 23, 2009 *On Energy Saving, Energy Efficiency Improvement and Amendments to Certain Laws of the Russian Federation*;

- Federal Law #399-FZ dated December 28, 2013 *On Amendments to Federal Law on Energy Saving, Energy Efficiency Improvement and Amendments to Certain Laws of the Russian Federation*;

- RF Ministry of Energy Order #400 dated June 30, 2014 On Approval of Requirements to Energy Audits and Results Thereof and the Rules for Submitting Energy Datasheet Showing the Results of Mandatory Energy Audit; or other document setting requirements to energy datasheet.

The energy audit objectives are:

- Assess actual FER consumption and identify FER saving opportunities;
- Develop administrative and technical measures to improve energy efficiency;
- Calculate annual FER savings;
- Calculate the investment amounts needed to implement planned measures;
- Identify energy saving opportunities by efforts of available staff and minimum resources.

The audit is conducted in the following production, office and residential facilities:

- Power supply and consumption facilities;
- Heat supply and consumption facilities;
- Fuel supply systems;
- Water supply and discharge systems.

The 2017 audit identified 25 energy saving opportunities with the potential to save 5,325 tonnes of oil equivalent i.e. 0.85% of 2016 total energy consumption, including: 316MW/h of electrical power (2.58% of 2016 total power consumption), 3,098KCM of natural gas (0.63% of total gas consumption) and 1,448KL of diesel (6.11% of 2016 total power consumption).

ENL uses electrical power, heat energy, diesel fuel, natural gas, gasoline, and marine fuels to support its operations. Diesel fuel, gasoline, fuel oil and low-viscosity marine fuel are used as a motor fuel for the company's onshore and offshore vehicles, miscellaneous low-mobility and fixed equipment. Diesel fuel is also used to feed diesel generators and power plants.

Produced natural gas and diesel fuel are used as boiler and furnace fuels for own heat and energy from gas turbine generators. Diesel fuel, gasoline, fuel oil and low-viscosity marine fuel are supplied by third parties. Key production facilities are fed by own power plants and external power network (Olympia Residential Community, YPO).

ENL's energy consumption is natural gas (91%), diesel fuel (4%), and gasoline, fuel oil and low-viscosity marine fuel (<5%).

CHAYVO ONSHORE PROCESSING FACILITY

Sakhalin-1 Chayvo Onshore Processing Facility (OPF) is an industrial facility comprising of technologically, administratively and economically interconnected and centrally controlled units designed to produce, process, transport and deliver oil and gas to customers.

Chayvo OPF processes well stream from Chayvo and Odoptu fields preparing it for further export via De-Kastri Oil Export Terminal located in Khabarovsk Krai. In 2015, the facility started to receive production from Berkut offshore platform located at Arkutun-Dagi field in the Sea of Okhotsk 25 km east of Chayvo OPF.

The power for Chayvo OPF is produced on site primarily through gas turbine generators, diesel is usually only used for startup or temporary needs. Chayvo Well Site (WS) is located on the seaside at 10km distance from OPF and power is supplied to the Chayvo wellsite from the OPF.

Key types of energy consumed by the production facility include natural gas, motor fuels and power as secondary energy resource. Electric energy feeds AC motors, heaters, communication and alarm systems, lighting, and HVAC systems, hot water supply, and heat tracing of process pipelines etc. Relay protection, control and alarm systems of electrical equipment are equipped with microprocessor controls. Automated Process Control System is used to control main electrical equipment.

Key measures to improve energy efficiency are:

- Replace outdoor and indoor lighting with energy saving bulbs;
- Improve technical metering system of main energy consumers for further analysis;

Chayvo OPF heat supply system is split into process and non-process areas. Heat energy is used for air heating, supply ventilation and process needs. In addition, Chayvo OPF uses electrical heat tracing of process piping and equipment, potable and firewater pumps located outside heated premises and potable and firewater tanks. Potential energy saving actions for the process area HVAC systems were developed at the engineering stage and implemented during construction. The non-process area does not have a centralized heat supply. Electrical heat convectors are equipped with thermostat to control heating power.

Key measures to improve energy efficiency taken in 2017:

- Briefing to cleaning personnel instructing to switch off the convectors when nobody is in a room or during inter-season period, or to turn them to minimum power during cold season.

In addition, in 2017 ENL took measures to minimize natural gas consumption i.e. developed operational mode charts for generators and oil heaters.

ORLAN OFFSHORE PLATFORM

Orlan offshore platform is a steel and concrete structure supporting a drilling, production and accommodation modules. The platform supports oil and gas production from the Chayvo field.

Process equipment on the platform allows for continuous and simultaneous drilling and hydrocarbon production. Treatment of well products on the platform is minimal, since the full well stream is fed to the Chayvo OPF.

Orlan has the following systems and equipment to support production operations and vital activities:

- Power generation and supply system;
- Heat supply system;
- Air supply system;
- Seawater intake and distribution system;
- Water cooling system for equipment;
- Freshwater treatment and distribution system;
- Waste and drain water collection and treatment system;
- Diesel fuel storage and distribution system;
- Incinerator.

The Orlan power generating system is designed to provide power supply for all electrical equipment including those supporting production processes, engineering systems, drilling operations and living quarters. The system configuration was designed with consideration for various operating modes, such as normal and emergency operations and cold start-up. The platform has power generation system of two types:

- Main power generation system;
- Emergency power generation system.

Power generation process is controlled via Power Management System (PMS). The PMS transmits power generation system data to Process Control System according to the parameters set by operators. All key parameters are displayed on the control panel.

PMS key functions:

- Monitor and trend power generation;
- Display and record non-process alarm;

- Share loads, including sharing of reactive and active power between generators operating in parallel;
- Shed the load if available generators cannot support the load;
- Interface with Automatic Process Control System to indicate electrical network status.

The Orlan electrical loads comprise of high and small capacity AC motors, heating and lighting systems, and office equipment.

Cumulative power consumption depends on the process equipment needs.

Heat energy on the platform is generated by three hot water boilers and one steam plant operating on diesel fuel, and electrical heating equipment.

Key measures to improve energy efficiency:

- Replace outdoor and indoor lighting with energy saving bulbs;
- Perform performance tests of boiler units to minimize diesel fuel consumption.

BERKUT OFFSHORE PLATFORM

Berkut offshore platform is designed for Arkutun-Dagi oil and gas field development and is located in the Sea of Okhotsk 25 km east of Chayvo OPF.

The platform consists of a gravity base structure holding a derrick, steel structures with production equipment, living quarters, cranes and a helideck. Berkut was installed in June 2014 and started production in 2015.

Process equipment on the platform allows for continuous and simultaneous drilling and condensate production. Produced condensate fluids consist of oil, water and gas (primarily methane) fractions. The platform has two-phase separation of produced fluids into oil and gas. Liquid crude is transported from the platform to Chayvo OPF through a pipeline and produced gas is used to fuel the gas turbine generators.

The Berkut power generating system is designed to support production processes, engineering systems, drilling operations and living quarters. The system configuration was designed with consideration for various operating modes, such as normal and emergency operations and cold start-up. The power generation process is controlled via Power Management System (PMS). Heat energy on the platform is generated by hot water boilers that use exhaust gases from Gas Turbine Generators, two diesel steam plants and electrical heating equipment.

Key measures to improve energy efficiency:

- Replace outdoor and indoor lighting with energy saving bulbs;
- Perform performance tests of boiler units to minimize diesel fuel consumption.
- Consider conversion of steam plants operating on diesel fuel to natural gas.

DE-KASTRI OIL EXPORT TERMINAL

De-Kastri Oil Export Terminal (OET) is located on the northeast shore of the Chikhachev Bay on the Klykov Peninsula in Ulchi District of Khabarovsk Krai, 6 km north of De-Kastri settlement and seaport and receives, stores, transfers and offloads export oil to tankers.

Main process facilities of De-Kastri OET include:

- Crude oil storage tanks, oil transfer pumps and associated engineering systems and facilities;
- Single Point Mooring (SPM) for tanker loading;
- Subsea loading line between the terminal and SPM.

OET has independent power supply system comprising of three gas turbine generators. The generators mainly use the natural gas coming from the SMNG-Shelf gas pipeline.

According to the design, the outdoor lighting of the entire territory shall be provided by high-pressure sodium vapor (HPSV) bulbs. The HPSV bulbs in outdoor lighting system are being gradually replaced with LED bulbs. In addition to power consumption advantage, they significantly improve the illumination quality.

In addition, high-pressure sodium arc bulbs, metal halogen bulbs and luminescent bulbs used in process and domestic premises are being replaced with LED bulbs. Share of LEDs in the said premises takes 79%. Replacement of obsolescent bulbs with LED ones has helped reduce lights rated capacity by 22,540W (12%). Heat is supplied by zones and generated by three separate WIESSMANN gas-fired boiler units. Each unit has two automatically operated boilers.

<u>Key measures to improve energy efficiency:</u>

- Optimize GTG loads;
- Optimize operation of the heat-supply system line pumps;
- Substitute luminescent bulbs with LEDs.

ODOPTU PRODUCTION FACILITIES

Odoptu production facility has one of the best designs in the world. In 2011, Odoptu First Stage Production project was chosen as one of four finalists for the *Excellence in Project Integration Award* by the International Petroleum Technology Conference (IPTC).

Odoptu production facilities include:
Process area with wellsite facilities, wellhead control units, modules and sites, including:
- Test and production separators site;
- Oil transfer pumps;
- Main power generator modules;
- Glycol-water heater site;
- Gas turbine compressor module;
- LERs;
- Fuel gas system area;
- Flare etc.

Auxiliary area with buildings and premises, including:
- ENL multipurpose building with control room and communication center;
- Camp;
- Mechanical shops and warehouse facilities;
- Security building etc.

Full water-gas-oil stream from all production wells is separated into crude, gas and water. Separated gas goes to the gas compression system, crude oil to the transportation system, and produced water to the produced water storage system.

Produced water from the storage tanks is treated and then injected into a dedicated well as needed.

Odoptu facilities use natural fuel gas as a primary fuel for gas turbine generators and compressors etc. Natural gas is also the primary fuel for crude pump engines, glycol-water heaters (i.e. for heat generation).

Odoptu has an independent power supply system with the gas turbine power plant used as the main source of electrical power. The facility also has three diesel power plants of equal capacity. They are the independent source of power supply and are constantly ready to start up and take over the load. They are intended for emergency power supply.

Annual power consumption varies by season. Power demand is higher in cold weather seasons due the need to operate pipeline heat tracing. The heat supply system is nominally divided into process and non-process areas. Heat in process area is generated by TEG heaters. Heat energy is used for air heating, supply ventilation and process needs. In addition, Odoptu uses electrical heat tracing of process piping and equipment, potable and firewater pumps located outside heated premises and potable and firewater tanks.

Non-process area does not have centralized heat supply. The area uses electrical energy generated by the process modules to satisfy its heat energy demand for HVAC and hot water supply. Electrical power is also generated by contractors' diesel generators.

<u>Key measures to improve energy efficiency:</u>

- Minimize natural gas consumption through mode testing of generators and ethylene glycol heaters and development of operational mode charts.
- Minimize power consumption for heating ENL multipurpose building through using the available conditioning units. Energy saving is achieved due to refusal from electrical heat convectors.
- Minimize power consumption for water heating by installing water saving devices at water supply points of the multipurpose building and the camp.