



Operations

Operations

Moving steadily forward, exploring the potential of tomorrow rather than resting on the laurels of today



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Korea is surrounded by the Yellow Sea, the East Sea, and the South Sea with extensive continental shelves of 300,000 square kilometers which have the potential for oil and gas exploration. Western oil companies such as Gulf, Shell, and Koam Corporation explored oil and gas in shallow waters between 1972 and 1982. KNOC began working on the shelves to acquire 116,549 line kilometers of 2D seismic data and 5,448 square kilometers of 3D seismic data and has drilled 47 wells.

In 1998, KNOC discovered a commercially viable gas field in Block 6-1 in the East Sea. The field, which was named Donghae-1, is about 60kilometers from Ulsan in the southern region of Korea. Its recoverable reserves are estimated at 186 billion cubic feet of natural gas and 3.2 million barrels of condensate. Although the amount of reserves is not massive, the field is meaningful as it represents the country's first commercial hydrocarbon development. In march 2014, the Company started to explore the Donghae 2 gas project (within 6-1C) located approximately 5.4 kilometers away from the Donghae-1 gas project, and drilled one production well named DH 2-1P in December 2015.

A large portion of the surrounding continental shelves has yet to be explored. Currently, there are two blocks in the Ulleung Basin.

Block	License	Licensed Area (km ²)	Stakes		Operator
8/6-1N	Concession	12,560	Woodside KNOC	50% 50%	Woodside
6-1E	Concession	1,300	KNOC	100%	KNOC

Ulleung Basin

Located in the East Sea between Korea and Japan, the Ulleung Basin has 10 kilometer thick clastic sediments in its southwestern margin where the Donghae-1 gas field was discovered. The basin consists of two exploration blocks, 6-1 in the south and 8 in the north, which are 12,918 square kilometers wide and 8,481 square kilometers wide, respectively.

Block 6-1 was first explored by Royal Dutch Shell Oil in 1971. The company acquired 5,193 kilometers of 2D seismic data before drilling its first exploratory well. The well, although not tested, encountered a number of gas shows. KNOC has paid attention to Block 6-1 after 1983. Since then, it has conducted numerous seismic surveys and twenty three drillings. These efforts resulted in thirteen minor discoveries of gas and two major discoveries of economically producible gas reserves in 1998, 2015 as described above (see Donghae-1, Donghae-2 section below for further information).

KNOC and Woodside Energy Limited which hold a 50% working interest, respectively signed the concession contract with Korea's Ministry of Trade, Industry & Energy(MOTIE) to explore deepwater blocks, Block 6-1 North and Block 8, in February 2007. During 10 years contracting period, two exploration wells, Jujak-1 and Hongge-1 were drilled in 2012 and 2015, respectively. KNOC and Woodside start to explore same area again at April, 2019 with a new concession contract.

Yellow Sea Basin

The Yellow Sea Basin has three exploration blocks, 1, 2, and 3 and includes a number of subbasins that are less explored compared to the Ulleung Basin. Through exploration activities, including drilling of six wells, the company acquired 35,827 line kilometers of 2D seismic data and 298 square kilometers of 3D seismic data.

Block 1 has an area of 34,470 square kilometers. KNOC and Texaco acquired 8,520 kilometers of 2D seismic data and drilled one exploratory well (Haema-1). Nine prospects have been proposed in the block so far.

Block 2 has an area of 39,446 square kilometers. Through collaboration with Gulf Oil and Marathon Oil, KNOC, including drilling of four exploration well, obtain 13,114 line kilometers of 2D seismic data and 298 square kilometers of 3D seismic data.

Block 3 has an area of 41,620 square kilometers. KNOC and Shell carried out the initial exploration from 1970 to 1997 without drilling a well.

In spite of no successful results, the Yellow Sea Basin is still considered to have highly potential areas according to a recent KNOC study. The study integrated newly acquired 2D and 3D data with the results of remote sensing analysis of satellite images, and adopted new processing techniques for new and existing seismic data. Besides, 2D seismic interpretation coupled with remote sensing analysis focused on offshore oil slicks allowed KNOC to discover new prospects in the area and do more accurate basin analysis.

Jeju Basin

The Jeju Basin is a tertiary basin located between Korea, Japan, and China. Block 4, 5, and 6-2 to the northeast span the basin. The young sedimentary area is defined by a series of NE-SW trending half-grabens with the highs separating the Socotra subbasin from the Domi subbasin. The Socotra subbasin spans the southern part of Block 4 and the Domi basin lies in Block 6-2. The southern boundary of the Jeju Basin meets the northern boundary of the Joint Development Zone (JDZ) between Korea and Japan.

Western oil companies, including Gulf, Texaco, and Shell began exploration in blocks 4, 5, and 6-2 in the 1960s. They obtained 12,781 kilometers of 2D seismic data and drilled one exploratory well in Block 4. In Block 5, 2D data of 11,995 kilometers was acquired and four wells were drilled, and in Block 6-2, 2D data of 12,786 kilometers was gathered and three wells were drilled. Through these activities, they discovered several oil and gas shows. In 2009, additional drilling was performed in Block 6-2.

The JDZ has been less explored compared to other blocks. In 2002, KNOC obtained 19,571 kilometers of 2D seismic data and 563 square kilometers of 3D seismic data and drilled seven boreholes. Three of them discovered oil and gas shows.

KNOC and several Japanese oil companies conducted a joint study on petroleum potentials throughout the JDZ area from 2004 to 2009. The study used the existing data integrated with satellite-derived oil seepage slicks. Recent discoveries near the Chinese coastline raised the chances of the hydrocarbon potential in Jeju Basin.

KNOC is looking for partners which will jointly explore Korea's continental shelves.

Block	Area (km ²)	Status
1	34,470	Open
1-2	414	Open
1-3	422	Open
2	39,446	Open

2-2	423	Open
3	41,620	Open
4	43,195	Open
5	44,529	Open
6-1	12,917	· 6-1C: Open · 6-1E: KNOC · 6-1N: KNOC & Woodside · 6-1S: Open
6-2	11,939	Open
8	8,481	· KNOC & Woodside
JDZ	82,557	· Subzone 1-6: Open

Updated : 2019-05-31

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▶ Donghae-1, Donghae-2 Gas Field

Block	Field	Operator	Year of Participation	KNOC's Share (%)
6-1	Donghae-1	KNOC	Aug. 1997	100
6-1	Donghae-2	KNOC	Sep. 2011	70

» History

KNOC successfully performed an exploratory drilling in the Gorae 5 prospect located in the middle of Block 6-1 in July 1998. This was followed by a feasibility study for development and three appraisal drillings until 1999. Based on the results of the study, development of the Donghae-1 gas field began in June 2001 with an exploitation permit from the Korea government. Construction of production facilities took two years from March 15, 2002 and production began on July 11, 2004. Commercial production started in November. In 2015, production well drilled to develop Donghae-2 gas field(Gorae-VIII structure) which is located 5.4km southwest from Donghae-1 gas field. After installation of subsea production facilities and pipeline connected to the Donghae platform, KNOC has successfully started up production from Donghae-2 gas field on July 2016.



Jul. 2016	First gas from the Donghae-2 field 1 production well 'DH2 1P'
Dec. 2015-Jun. 2016	Donghae-2 production well drilling and production facilities installation
Sep. 2011	Award of concession contract of 6-1C block for Donghae-2 development
Nov. 2009	Start production from the additional gas well 'DH1 4P'
Jul. 11, 2004	Begin the first gas from Donghae-1 field 3 production wells (DH1 1P/2P/3P)
Dec. 31, 2001	Sign an installment, procurement, and construction agreement
June 2001	Obtain an exploitation permit from the Ministry of Commerce, Industry and Energy
Sept. 2000-Nov. 2001	Build front-end engineering and detailed designs
Feb. 2000-Aug. 2000	Establish a development plan and conduct an environmental impact assessment

» Business Outline

The Donghae-1 and Donghae-2 gas field contains the late Miocene sandstone reservoirs which are believed to be deformed shallow marine sands sealed with silty shales. Development of the gas field marked a milestone in the history of the company. With Donghae-1 gas field, KNOC became the first oil and gas producer in Korea.



	Daily production (2018 annual average)	Production period
Donghae-1	9.7 million cubic feet	2004-2021
Donghae-2	21.7 million cubic feet	2016-2021

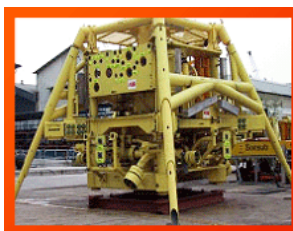
- **Buyers** : Korea Gas Corporation (natural gas) and S-Oil (condensate)

- **Facilities**

The production facilities of the Donghae-1 and Donghae-2 gas fields consist of a subsea production control system, an offshore platform, topside facilities, an export pipeline, and onshore processing facilities.

- **Subsea production control system**

Main subsea equipment has five subsea christmas trees that control gas production; five flowlines that convey gas to the offshore platform; and an umbilical line that supplies power and chemicals such as methanol and monoethylene glycol.



- **Offshore platform and topside facilities**

Offshore platforms consist of 163 meter high jackets with four legs; three story topside decks with eight files of 72 inches in diameter; and a 152 meter high undersea section. The platform was designed to withstand wind velocity of 50 meters per second and waves of up to 17.5 meters (record breakers in the last 100 years). The facilities are able to endure an earthquake of up to magnitude 6.5 on the Richter scale.



- **Pipeline**

A gas pipeline runs 68 kilometers from the offshore platform to onshore facilities: 61 kilometers undersea and 7 kilometers above the ground. Gas is then transported to Korea Gas Corporation's facilities through the 7 kilometer long pipeline.

- **Onshore processing facilities**

Onshore processing facilities consist of processing facility, electricity equipment, and office areas. The daily maximum processing capacity is 75 million cubic feet.

- **Operation and management**

To maintain high standards in health, safety, and the environment (HSE), KNOC established the HSE management system. The system, which was certified with ISO 9001, ISO 14001, etc, was adopted for all of the company's processes and facilities around the world.

KNOC has made systematic efforts to enhance its operations regarding the Donghae-1 and Donghae-2 gas fields. Policies and procedure established exclusively for the gas field include general policies for Donghae-1 and Donghae-2 gas fields; risk management procedure; onshore emergency response procedure; platform emergency response procedure; Permit to Work system; oil spill contingency plan; change procedure management; and inspection, measurement, and test equipment control procedure.

» **Outlook**

Production in the Donghae-1 gas field had Korea join the ranks of oil producing countries. This is significant for the country because it is now able to meet a part of its energy demand with natural gas produced in its own territory.

Through the Donghae-1 and Donghae-2 development project, KNOC accumulated experience and knowhow in all areas from exploration and development to production and distribution. The accumulated intangible assets will ultimately help Korea's oil and gas industries improve their technologies and raise their competitiveness to the next level.