Developing Kupe

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Abstract

The Kupe Field was discovered by New Zealand Oil & Gas Ltd when Kupe South-1 was drilled in 1986. Several further wells have delineated the central part of the field as well as a number of small separate pools, but development was delayed 15 years due to the dominance of Maui. Gas prices in New Zealand have been constrained by Maui gas which is relatively cheap by international standards.

This has fundamentally changed and with natural gas forming an important component of New Zealand's energy supply, both as a feed stock for industrial processes and as a fuel source for electricity generation, the Kupe field is an important strategic component of New Zealand's energy resources. The electricity sector in particular, requires, inter alia, Kupe gas to be bought to market in order to meet the projected growth in electricity consumption and to allow the economy to grow unconstrained.

With gas prices rising development of the Kupe field is being actively progressed. Five potentially productive areas are recognised: namely the Central Field Area, the Leith Prospect, the Stent Prospect, the Denby Prospect, and the Marshall Prospect. Because of this a phased approach to development will be taken with the initial development focussed on the Central Field Area.

This paper discusses the importance of the Kupe field for the New Zealand energy sector and the Kupe Joint Venture's planned approach to development.

Introduction

The Kupe Field, located approximately 30 kilometres offshore in the Taranaki Basin in 30 meters of water, was discovered by New Zealand Oil & Gas Ltd in 1986 when Kupe South-1 was drilled. The Kupe field is not big enough to support a liquids stripping/gas re-injection project, and the lack of an adequate gas market has prevented development of Kupe for over 15 years.

With last year's finding by the Independent Expert under the Maui contract that Maui's reserves are significantly lower than originally estimated, and the press reports that Pohokura reserves are more likely to be 600PJ to 800PJ rather than the originally envisaged 1,000PJ, there has been evidence of an upward pressure on gas prices.

This has given Kupe a higher profile and has provided the joint venture parties with comfort that Kupe can be developed economically. To this end the Kupe joint venture commissioned an initial engineering study in the second half of 2003 to:

1. review the existing offshore facility and pipeline concepts for the development of the Kupe Central Field Area ("CFA"): evaluate and update these for the recent advancements in technology that has occurred since the original studies were undertaken, and cost and rank the alternatives;
2. identify the onshore processing, transportation and storage options for the Kupe project and screen, cost and rank the alternative onshore development concepts; and
3. identify environmental and permitting issues.

This paper discusses the importance of the Kupe field for the New Zealand energy sector, the findings of the initial engineering study, an indication of the Kupe Joint Venture's planned approach to development, the necessary conditions for the timely development of the CFA and the indicative development program.

The Kupe Resource

Kupe refers to Petroleum Mining Licence ("PML") 38146 and consists of six key reserve areas, namely the Central Field Area, the Leith prospect, the Stent prospect, the Denby prospect, the Marshall prospect and the Toru prospect (see Figure 1).

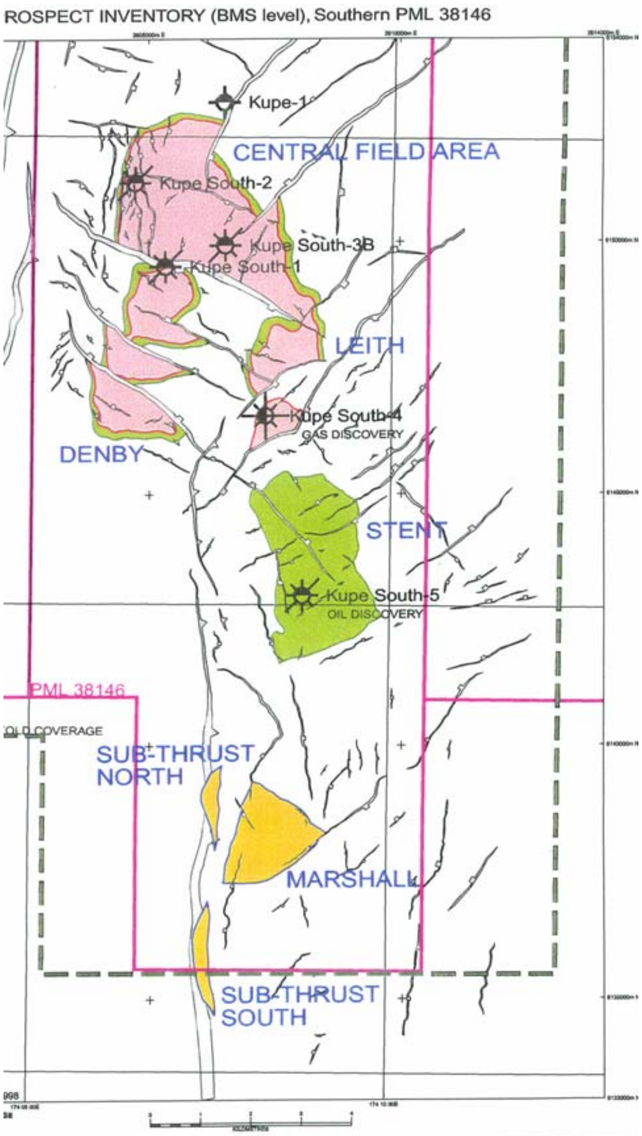

Figure 1. Kupe Prospects

As Figure 1 shows, the CFA contains three wells (Kupe South-1, South-2, South-3B) and also covers the immediately located Denby reserve area. To the south of the CFA are the Leith and Stent possible reserves where Kupe wells South-4 and South-5 are. Located immediately north of the CFA is the Kupe 1 well, and north of this is the Toru prospect area (not shown in Figure 1).

The initial development of Kupe will occur within the CFA, where three wells have confirmed proven and probable reserves of approximately 260PJ of gas and 16 million barrels of oil. This estimate has not attributed any commercial hydrocarbon reserves to the Stent, Denby, Leith or Marshall prospects and is therefore deemed to be conservative. Sales gas will initially be 20PJ per annum.

Expansion of the initial development is expected, firstly, by infill drilling to increase CFA reserves, and secondly by connecting satellite developments in the rest of the licence area into the CFA infrastructure. In particular, the Stent and Marshall prospects to the south of the CFA offer opportunity for such satellite developments. Both of these prospects exhibit direct hydrocarbon indications, similar to those over Kupe, and potentially could double or triple reserves. The Toru prospect is a further development opportunity.

The CFA is located in 30 metres of water 30 km from the South Taranaki coast. The offshore environment in this location is best described as harsh both in terms of weather and sea conditions. The CFA reservoir is geologically complex with the producing horizon being the deep Farewell formation. The well stream gas contains approximately 12% carbon dioxide, making it corrosive and prone to hydrate formation. A 20m oil column underlies the gas cap and both the condensate contained in the gas and the oil are waxy.

Kupe and the New Zealand Market

Natural gas forms an important component of New Zealand's energy supply, both as a feed stock for industrial processes and as a fuel source for electricity generation. In the year to 31 March 2002, approximately 48% of New Zealand's natural gas was used for electricity generation with 37% being used by the petrochemicals sector.

As a result of the run down of the Maui gas field and the continued growth in energy demand New Zealand faces the prospect of a primary energy 'gap' from around 2008-2010. This has been exacerbated by the fact that gas reserves have not been replaced by new discoveries and developments. The Kupe field, being one of only two discovered and undeveloped fields with proven and probable reserves in excess of 200PJ, is therefore an important strategic component of New Zealand's energy resources.

As Figure 2 shows the electricity sector in particular, requires, inter alia, Kupe gas to be bought to market in order to meet the projected growth in electricity consumption and to allow the economy to grow unconstrained. Given that gas discovery in New Zealand has been very irregular and that there can be long lead times to bring new fields into production, Kupe, when developed, will be a key component of New Zealand's gas supply over the medium term.

Development Concepts

The Kupe joint venture has, over a number of years, undertaken several studies to identify development options for the Kupe field. The initial development concepts envisaged a fully manned offshore platform while later work has focussed on normally unmanned, minimum facility concepts.

In addition, some consideration has been given to various gas recycling scenarios. These scenarios have been premised on development initially being based on liquids production and with most of the gas being re-injected until a gas sales contract could be successfully negotiated. This type of development is no longer relevant as there is now a market for Kupe gas.

To bring Kupe gas to market the joint venture partners commissioned an initial engineering study as a pre-cursor to FEED. The development scenarios developed during the initial engineering study conducted by Transfield Worley have been determined taking regard of the necessity to:

- minimise capital costs to ensure an economic development;
- adopt a "fit for purposes" approach;
- minimise risk; and
- if cost effective, allow for the possibility of future developments.

Development of Scenarios

Previous concept screening work undertaken by former operator Fletcher Challenge Energy and by New Zealand Oil & Gas Ltd has been a key input into the initial engineering study. The recent study has updated this previous work, where appropriate, particularly in the light of new technology, refined construction methodologies and the current market conditions. In addition, given the focus of previous work on the offshore components of development, the identification the onshore processing, transportation and storage options for the Kupe project has been a key element of the work.

Offshore Platform Scenarios

The relative size of the Kupe reserves (compared to other existing offshore fields) has required that development is relatively low cost. The scenarios considered for the offshore development have therefore been based around a normally unmanned minimum facilities platform. Platform services, including control, power, inhibitors for wax, hydrate and corrosion management are provided from the onshore production system. This keeps the platform robust and simple with minimum maintenance requirements allowing normally unmanned operations.

Two platform cases were investigated:

- a normally unmanned installation with marine access only; and
- a normally unmanned installation that can accommodate helicopter access.

Marine Access Platform

The marine access platform has an absolute bare minimum of equipment on the topsides. Platform access is by boat only and there is no helideck or lifeboat. This development scenario could be described as a "subsea development that has the wellheads above sea level". Planned operational and maintenance visits to the platform would be on an annual basis.

As pigging of the subsea pipeline is expected to be frequent, given the waxy nature of the Kupe condensate, dual pipelines to shore are considered necessary (see next section) for this type of platform. This is because boat access to the platform

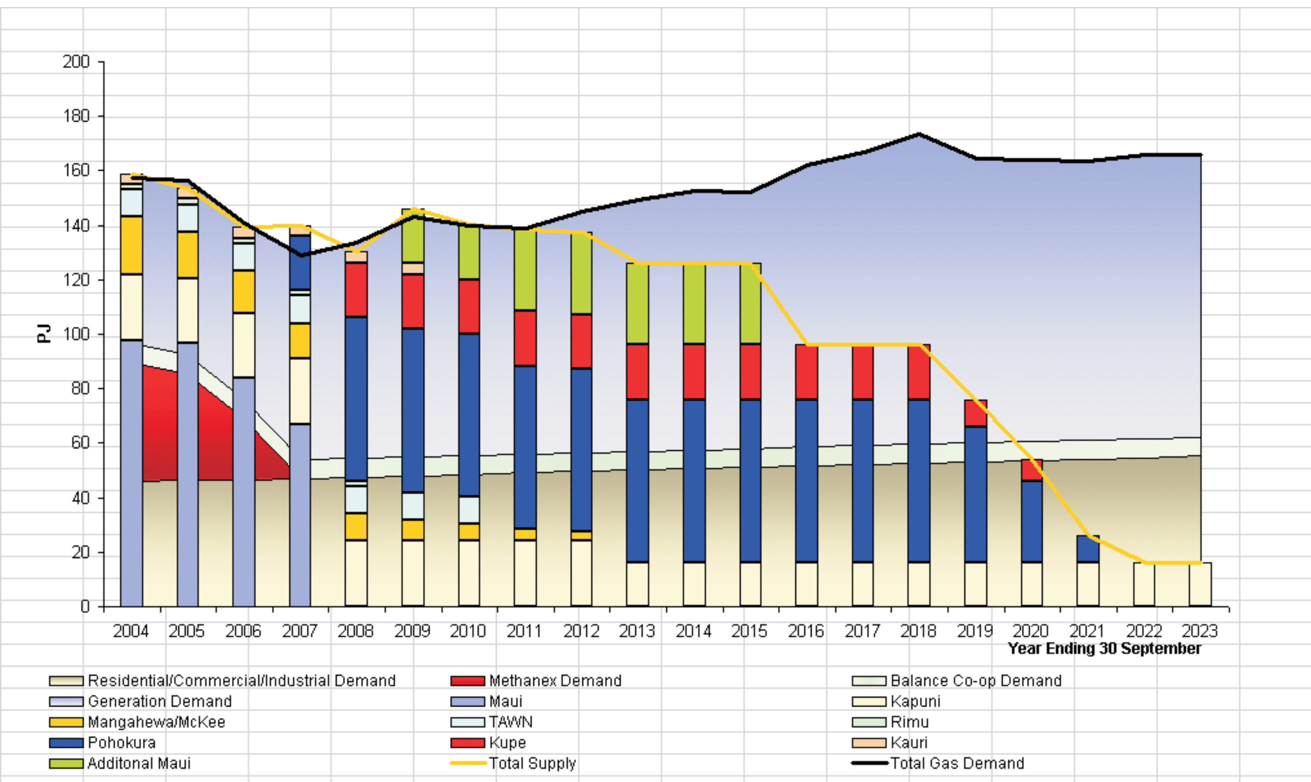

Figure 2. Gas Supply and Demand

can only be undertaken in good weather, making visits to the platform (to replenish the pig launcher) prone to delays. On the other hand, the dual pipeline configuration enables wax scraper pigs to be launched from shore to the platform and looped back down the other pipeline, back to shore.

In line with this philosophy, all equipment is designed for simplicity, high integrity and a minimum of moving parts. There is no crane on the platform and facilities for well intervention are limited to some wire lining operations.

Helicopter Access Platform

As with the marine access platform the helicopter access platform has no process equipment on the topsides. Platform access is by helicopter, requiring a helideck and possible life raft to form part of the topsides. This opens up the possibility of using a single pipeline to evacuate the well stream to shore, since reasonably frequent visits to the platform could be made to replenish the pig-launcher with scraper pigs.

To facilitate the offshore pigging operations, a crane is included in the topsides design.

Recommended Configuration

As indicated, the platform type is critically dependent on the subsea pipeline configuration adopted – whether single or dual pipeline. Indeed both the platform and pipeline are designed as a single offshore production system. Therefore a discussion on the other half of the "offshore production system" is necessary.

Subsea Pipeline

The Kupe field is characterised by several features which makes the design of the subsea multiphase pipeline complex. These features include:

- a wet well stream that is prone to hydrate formation;
- a carbon dioxide content of approximately 12% which could lead to high corrosion; and
- waxy condensate.

With no offshore processing, the full well stream is transported from the platform to onshore processing facilities. The flow is three-phase and is susceptible to wax and hydrate issues. These will be managed by the injection of pour-point depressant and glycol. This requires two, separate chemical injection lines to be installed due to the incompatibility of the two chemicals. It is likely that these chemical lines will be piggy-backed to the subsea pipeline.

The initial engineering study investigated two pipeline configurations:

1. a single multiphase pipeline to shore, requiring all pigging operations to be conducted from the platform; and
2. dual pipelines which allows for round-trip pigging initiated from the beach.

Compared to the single pipeline configuration, the dual pipeline system minimises the operational risk and offers greater operational flexibility and control. In particular, it allows for improved hydraulics due to smaller onshore slug catchers, greater turndown flexibility and potentially reduced risk of corrosion. The significant downside however is a significantly higher capital cost despite the dual arrangement allowing smaller pipeline diameters to be used.

Pipeline Materials

The initial engineering work recommends that the pipelines be constructed from carbon steel. Although corrosion resistant alloy systems would enable smaller pipeline diameters the total installed cost for carbon steel is significantly lower and it is therefore the preferred pipeline material. Furthermore, the configuration of two chemical injection lines still works for a carbon steel pipeline as the corrosion inhibitor can be mixed with the glycol.

The downside with the selection of carbon steel is the ongoing operating costs associated with corrosion inhibitors. Even taking this into account, the life-cycle costs of carbon steel is still superior to the other options and remains the preferred material for the subsea pipeline.

High Integrity Pressure Protection Systems

The initial engineering study considered the use of a High Integrity Pressure Protection System ("HIPPS") to allow the design pressure of the subsea pipeline to be reduced and thus to save pipeline capital costs. It was found that the use of HIPPS does yield some costs savings, however from a risk perspective the use of HIPPS is not currently recommended.

In particular, a HIPPS system introduces added complexity to the platform which increases the requirement for platform visits to maintain the HIPPS system. This makes HIPPS untenable for a platform where access is by boat only and is only recommended for consideration for platforms with helicopter access.

The HIPPS system may also increase the risk of production deferment due to the platform shutting down if there is a failure or trip of the HIPPS system.

Thus, while HIPPS offers some capital costs savings these are offset by increased risks associated with platform maintenance and production deferment. As a result, HIPPS is not currently recommended for the carbon steel subsea pipeline. However, HIPPS does present a modest value-improvement opportunity in terms of reduced capital costs.

Flow Assurance

It is rare for any offshore development to have the combination of wet, waxy, corrosive fluids which are prone to hydrating that Kupe has. The combination of these three factors has made the resolution of flow assurance issues in a cost-effective measure one of the most challenging aspects for the Kupe development.

From a flow assurance perspective, the dual pipeline system was found to offer clear advantages over the single pipeline configurations:

- de-waxing pigs can be launched from shore without needing to rely on platform visits (which are weather dependent) nor on an emerging technology for the remote launching of multiple scraper pigs;
- control of the pig is easier due to the ability to manage flows on either side of the pig; and
- the ability to potentially isolate the pipeline during periods of low production improves the flow regime and dynamic operational control of the pipeline.

In addition, the dual pipeline configuration simplifies the platform design as no offshore pig launcher is required. This removes one of the key drivers for regular platform visits, removing the need for a helideck and the associated ancillaries such as a gas detection system.

Offshore Production System Recommendation

There are two, clear choices for the Kupe offshore production system:

1. a boat-access platform with a dual pipeline arrangement with pigs launched from shore, or
2. a more complex platform with a helideck and remote pig-launcher feeding a single subsea pipeline.

The boat-access platform and dual pipeline arrangement presents lower operational risk and potentially improved production availability. This is due to a combination of three factors:

- pigging of the pipeline may have to be performed as regularly as daily (and probably not less than several times per week) when the field is initially produced;
- remote launching of wax scraper pigs from a canister of, say, five or more pigs is necessary for a normally unmanned facility. Although this technology is well established for spherical pigs, it is considered to be too immature for wax-scraper pigs to be currently recommended for Kupe without reservation; and
- the offshore sea conditions in South Taranaki may prevent access to the platform for periods of several (or more) days. This may mean the pipeline cannot be pigged when required should there be problems with launching pigs (due to launching problems or insufficient pigs in the canister). In this event, production from the platform may need to be reduced or even shut-in until the pipeline is able to be pigged. In contrast, pigging from shore enables pigging schedules to be more reliably maintained (as no weather-dependent platform visits are required).

Although the boat-access platform is cheaper than the helicopter-access platform (due to simpler topsides) the costs associated with the dual pipeline arrangement make this "offshore production system" substantially more expensive compared to the alternative comprising of a helicopter-access platform and single pipeline. If the remote launching of scraper pigs can be satisfactorily resolved, together with issues of somewhat lower production availability, then a clear opportunity exists to improve value for the Kupe development using a single pipeline (and therefore a platform requiring a helideck). This is a matter the Kupe joint venture parties will be exploring during front-end engineering development ("FEED").

Onshore Plant Scenarios

Two gas plant concepts were assessed during the initial engineering study, namely:

- a simple plant processing the multiphase well stream to produce sales gas meeting NZS 5442, 1999 and condensate; and
- a more complex plant capable of producing not only sales gas and condensate but also segregated LPGs.

The study found that a simple gas plant, producing sales gas and stabilised condensate can be designed to meet the required product specifications without the need to extract LPGs from the well stream fluids. The simple plant has clear capital cost advantages the more complex plant and is the currently preferred option. Indicative analysis suggests that the additional capital costs involved to enable the separate recovery of propane and butane is not value adding given the current gas market. During FEED this will be assessed in greater detail in conjunction with further well stream compositional sensitivity analysis.

The study developed not only new, greenfield plant concepts but also identified alternative processing options through the use of existing oil and gas infrastructure. The four existing production stations within Taranaki were all considered candidates for processing Kupe gas and condensate:

- the Swift Energy Rimu Production Station (SERPS);
- the STOS Maui Production Station (MPS) at Oaonui;
- at Kapuni using the combined facilities of the NGC Kapuni Gas Treatment Plant (KGTP) and the STOS Kapuni Production Station (KPS); or
- the Swift Waihapa Production Station using the Tariki-Ahuroa gas plant (TAG).

The Kupe well stream fluids will arrive onshore at a landfall near the Tangahoe river mouth. To make use of existing infrastructure it would be necessary to transport the Kupe well stream fluids overland to all of the abovementioned processing facilities (with the exception of the Rimu Production Station option which is adjacent to the subsea pipeline land-fall). To process the Kupe well stream at the other locations new relatively long pipelines (around 26 to 57 km depending on the plant in question) would need to be installed.

The study found that processing of Kupe is technically feasible at all of the existing processing plants in Taranaki. This will necessitate, in most cases, some capital expenditure. In addition, depending on the production scenario considered, facilities may be required at the landfall site in order to transport the Kupe well fluids and achieve minimum arrival pressure at the existing production stations.

Having determined that processing Kupe gas is technically feasible at existing processing plants the Kupe joint venture intends, in the near future, to initiate discussions with existing operators to ascertain their appetite or otherwise for processing Kupe gas. In addition, the Kupe joint venture parties will further develop the greenfields concept.

Conclusions

The recent write-down of reserves in the Maui gas field, and an increasing need for gas-fired electricity generation to supplement New Zealand's hydro generation has led to increasing gas prices and projected shortfalls in the supply of gas in coming years. This has provided the Kupe joint venture parties with comfort that Kupe can be developed economically. To this end the Kupe joint venture has recently completed an initial engineering study that has provided a sound basis upon which the new operator will be able to commence final development planning, including obtaining government and environmental approvals.

The Kupe joint venture parties now envisage, having completed the initial engineering study that FEED will begin in the first half of this year. Initial work will be to ensure that the joint venture is in a position to begin the process of seek the necessary consents by the end of 2004.

The final development is expected to be on line by April 2007, and will likely produce around 20PJ per annum of sales gas and the order of 1.5 million barrels of liquid hydrocarbons (condensate and possible LPG).

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