

Karish and Tanin Development: Israel

"Initial thoughts on the development of these strategically important natural gas assets"





November 29th 2016

Dr. S.R.Moore (Technical Director)

Introduction: Energean Oil and Gas and the Prinos Basin



Energean at a glance

- Private E&P company with focus on the Mediterranean Sea and North Africa
- The only Oil & Gas producer in Greece approximately 5,000bbls/day current production from the Prinos field
- 60 mmbbls 2P+2C Reserves/Resources
- Significant further upside potential through application of EOR techniques
- New 3D over Prinos basin acquired 2015
 - being employed to refresh nearfield exploration potential
- USD200 mm low risk ongoing investment plan to increase production to 15,000bbls per day – 20+ wells: 4 already drilled
- Exploration upside in Western Greece, Egypt and Montenegro
- Experienced Management Team with significant International Oil Industry track record
- Unparalleled HSE track record with 35 year offshore production history in environmentally sensitive areas in the Mediterranean
- Entrance to Israel represented a key element of the company's agreed growth strategy







Background: technical and environmental challenges

- Energean has, over the last 30+ years, successfully managed the exploration, appraisal, development and production operations for a technically complex group of assets in the north Aegean Sea.
 - Pristine environmental location 5km from tourist resorts
 - High pressure fields located pre-salt
 - Hydrogen Sulphide concentrations up to 60% in gas phase
 - Significant Carbon Dioxide concentrations
 - Offshore: minimum-manned platform operations
 - Onshore: large gas and oil processing complex including sulphur production
 - Operation of own drilling and workover rigs
 - SPM Buoy and tanker loading operations
 - Marine logistics fleet
- Success underpinned by sound engineering and operations practices, fit for purpose management systems and rigorous application of HSE-MS and HEMP principles







Prinos Basin assets: significant operational complexity

- Prinos complex comprises four platforms:
 - 2 drilling jackets
 - 1 process platform (Delta)
 - 1 flare platform
- South Kavala (sweet) gas field ties back to Prinos
- Prinos Delta:
 - Gas Oil separation and gas dehydration
 - Water Oil separation and water treatment/disposal
 - Sea water treatment for water injection
- Dry gas and dehydrated oil sent to onshore processing plant (Sigma):
 - H2S removal (amine)
 - Sulphur production (claus)
 - Oil de-salting and stabilization
 - Condensate and LPG production
 - Power generation
 - Crude storage and loading via SBM





Committed to fully realising Greece's oil and gas potential

- Drill 1 development wells in Prinos

 (10 from Prinos A (inc. 1 to Prinos North), 7+ in Epsilon
 (from new Lamda platform) and 4+ from Prinos B)

 Install new unmanned platform on Epsilon field (Lamda)
- 2. Increase production to 10,000+ bbls per day
- 3. Identify new exploration targets from 3D seismic
- 4. Explore Ioannina (Western Greece acreage)
- 5. Develop West Katakolo discovery

The file

6. Develop the first UGS project in Greece



2014-2017: US\$ 200 million Investment plan



Karish and Tanin fields: Israel



Asset history and acquisition process

- Tanin & Karish were discovered by Noble in 2012/13 and contain audited 2C Resources in excess of 3 Tcf (GIIP) of sweet biogenic gas and 25 mm bbls light oil (STOOIP)
- Delek Drilling and Avner were required to sell 100% of their holdings in the Karish and Tanin fields. Noble's equity in these fields was earlier purchased by Delek/Avner
- Energean concluded a deal with Delek on August 16th
 valued at \$148 mln plus forward royalties from production.
 \$40 mln payable at deal closing
 - Deal closing expected December 2016 when final approvals received from Israeli Petroleum Council
- Both fields are ready to be developed with no need for further appraisal. Produced gas must be sold domestically in Israel
- Energean has completed initial Feasibility studies. It has recently awarded a contract for "End Feasibility" engineering to Granherne (KBR)
- Energean targets first gas early 2020 from the Karish field.
 Concept Engineering will commence late 2016.
- Energean plans to employ a single EPCIC contractor to execute the entire project scope

Asset Location





Introduction to Karish and Tanin discoveries

- The Tanin and Karish fields were discovered in 2012 and 2013, and are the 6th and 7th discoveries made by Noble in the Levantine basin
 - Karish-1 proved 2 Tcf GIIP
 - Tanin-1 proved 1.2 Tcf GIIP
 - Karish C sands represent first significant offshore oil discovery
- Both fields are part of the prolific Early Miocene Tamar Sands play
- The fields are located north of the Tamar field, in water depths exceeding 1700m
- Discovery wells de-risk adjacent prospective fault blocks which represent a significant upside
 - Karish lease: 0.5 Tcf in Karish North
 - Tanin lease: 0.8 Tcf in Eastern fault blocks
- Deeper targets in Jurassic identified below Karish and Tanin blocks. Latter extends below Leviathan discovery
 - Jurassic expected to be thermogenic oil play





Regional setting

Regional and field Geological overview





Karish: field overview

- Mapped from 3D seismic based upon amplitude anomaly. Discovered GWC conforms to anomaly and matches seismic flat spot
- Karish-1 spudded on 21 March 2013 and reached a total depth of 4,812 m. Duration 77 days(AFE 95 days): \$69.5m
- Discovered 135 m gross gas column with 72 m of net pay over three Tamar A-B-C Sands (90% of net pay in C-Sand)
- The Karish-1 well is abandoned over the reservoir interval, but available to be sidetracked
- A/B sands: biogenic gas CH4 > 98% plus condensate CGR=4
- C sand: biogenic gas plus thermogenic oil CH4 > 95%,
 CGR = 25 bbl/mmscf. Implies partial charge from deeper source
- Karish-C sands represents the only Levantine basin accumulation to date with significant oil content
- The Karish-1 discovery helped de-risk adjacent prospect Karish North
- Lease was granted November 2014 for 30 years covering the field plus adjacent exploration targets – no gas exports rights







Tanin: field overview

- Tanin mapped based upon 3D amplitude anomaly.
- Tanin-1 spudded on 9 Dec 2011 and reached a total depth of 5504 m. Duration 88 days (59 days AFE): \$72m
- Discovered 31m gross gas column with 24 m of net pay in two Tamar (A and B) Sands (55% of net pay in A-Sand)
- The Tanin-1 well is abandoned over the reservoir interval, but available to be sidetracked
- Hydrocarbons primarily biogenic gas with C1 composition > 98%.
 Same as Leviathan and Tamar
- The Tanin-1 discovery helped de-risked the adjacent fault blocks within the Alon-A license included in development Lease
- A development lease was granted November 2014 for 30 years covering the discovery and adjacent exploration fault blocks – no gas export rights





Developments offshore Israel



Main gas discoveries Offshore Israel since 1999: Over 40TcF





Tamar and Mari-B existing infrastructure





- Tamar is the only deep offshore development online currently
- It was designed for 1,2 Bcf/d with initial capacity at ~0,9 Bcf/d (step up expected in 201718 period)
- Initial plans for onshore processing facility thwarted due to environmental issues
- Field eventually developed via one of the world's longest multiphase pipelines to a new platform located adjacent to Mari-B



Leviathan: Phase 1 overview



Noble (40%), Delek (45%), Ratio (15%) Phase 1 cost expect ~4 billion USD for 12 Bcmpa

- Development delayed by 3 years by political, legal and regulatory issues due to size of the field and antitrust laws
 - Led to the eventual sale of Karish and Tanin
- In June 2016, a "Tamar lookalike Plan Of Development" with tie-back to the northern part of Israel, was approved by the Petroleum Commissioner
- The fixed platform's initial capacity will be 1.2 Bcf/d and is expandable to 2.1 Bcf/d (ie 12 to 21 BCM pa)
- Leviathan will provide a second source of supply and a new entry point for gas into Israel's domestic gas system
 - Will also export to regional countries.
- FEED contract was awarded to Wood Group Mustang (same as for Tamar), FID is expected by the end of 2016 and first gas by 2019
- Small local gas sales contracts announced
- Export contract with Jordon also announced



Leviathan: Export routes and expansion

Phase 1 shallow water platform expanded to allow capacity to be increased from 1.2 to 2.1 Bcf/day. Export pipelines to originate from both the Leviathan and Tamar shallow water platforms

Phase 1 of Leviathan development - approved by the Petroleum Commissioner

- Development plan for phase 1 includes construction of an offshore fixed platform with a 2.1 bcf/d (approx. 766 bcf/y) capacity
- Estimated Capex -5-6 US\$ billion for the full development (2.1 bcf/d), of which the first stage to the domestic market, Jordan and the P.A. (1.2 bcf/d) CAPEX of 3.5-4 US\$ billion



First stage to the domestic market, Jordan and the P.A. Capacity of 1.2 bcf/d (approx. 438 bcf/y)







Export pipelines to Jordan, Shell-Egypt LNG and Egyptian domestica market expected in phase 1. Phase 2 holds potential for sales to Turkey and Palestinian authority



Israel - Domestic market

Preliminary development thoughts regarding Karish and Tanin



Where we are in the maturation process



- Karish/Tanin development project is nearing the end of the Assess phase:
 - An extensive range of development options have been identified, reviewed and valued
- A small amount of technical work remains to support high level concept decision prior to entering Select Phase:
 - Fluid characterization
 - Pipeline Hydraulics including sensitivities for increase in OGR and WGR
 - Floater selection & pricing refinement for the Offshore focus concept
 - Deliverability/Availability comparison of the identified production concepts



Key development strategies analyzed

Solution Space

Onshore focused developments



Methodology

Offshore focused developments

- Define a set of company <u>Value Drivers</u> which would enable subsequent ranking of the key development strategies
- Respect <u>barrier conditions</u> imposed by Israeli regulations
- Prepare scenarios that address <u>Base Case contingent resources</u> (2C GIIP-NSAI CPR) & associated well count (Karish-3, Tanin-2)
- Address impact of reservoir back pressure on Reserves : <u>identify development dependent Reserves</u>
- Determine <u>CAPEX, OPEX and Schedule</u> using Que\$tor software. Assess economic parameters
- Assess Flexibility of development strategies to <u>address upside opportunities</u>
- Assess <u>risks and opportunities</u> (hence value) quantitatively and qualitatively
- Prepare overall ranking based upon calculated economic value and assessed risk/opportunity level



Base Case: Tamar Lookalike development

Deepwater wells & gas gathering with flowline tie-back to shallow water processing platform





- Deepwater wells & tree system with gas gathering production manifolds in ~1,750m WD at Karish & Tanin
- ~40km infield and ~100km tie-back flowlines to shallow water production platform
- Multiplex optical/electro-hydraulic control system
- 4" MEG flowline from SWP and continuous MEG injection at wells (hydrate mitigation)
- Fixed jacket production platform in 100m
- Export gas and condensate pipelines to shore (~15km) at Dor
- Onshore gas and condensate pipelines to Hagit power station (~15km) and (condensate) to Haifa refinery (~30km)

Proven development concept used for Tamar and planned for Leviathan



Alternative 02: Maximize Onshore Assets

Deepwater wells & gas gathering with flowline tie-back to shore and onshore gas/condensate plant

Deep water wells and gas gathering with multiphase flow line tie-back to onshore gas/liquids processing plant



- Deepwater wells & tree system with gas gathering production manifolds in ~1,750m WD at Karish & Tanin
- ~40km infield and ~110km tie-back flowlines to onshore production facilities
- Multiplex optical/electro-hydraulic control system
- 4" MEG flowline from onshore facilities and continuous MEG injection at wells (hydrate mitigation)
- Pressure let down facility in near shore location (subsea valve module) in 60m WD
- Onshore gas and condensate pipelines to Hagit power station (~15km) and onwards (condensate) to Haifa refinery (~30km)

Lowest cost option but introduces additional complexity with respect to Environmental permitting. Longest schedule



Alternative 01: Maximize Offshore Assets

Deepwater wells & gas gathering to FPSO located near the field and dry gas export pipeline to shore

Deep water wells and gas gathering to floating production facility located above Karish and dry gas pipeline to shore



- Deepwater wells & tree system with gas gathering production manifolds in ~1,750m WD at Karish & Tanin
- ~40km infield (T) and ~5km (K) tieback flowlines and production risers to FPSO (turret or spread moored)
- Multiplex optical/electro-hydraulic control system
- Fluid separation, oil storage and offloading, gas compression at FPSO together. Simple hydrate management facilities
- Export risers and pipeline (~110km) to shore (Dor) / Shore crossing and block valve station / Onshore gas pipeline to Dor Gas station (~1.5km)

Traditional approach with lowest technical and execution risk but highest cost. Smallest environmental footprint. Fastest Schedule.



Examples of optimization studies: offshore option



Similar work being undertaken for all main development concepts



Energean Project Controls



- Energean employs a simple but effective stage-gate process typical of the upstream EP industry
 - The project is currently progressing through the Assess stage
 - The objective is to take a single option into the Select phase
 - An EPCI contractor will be selected as early as possible with the intent to agree a lump sum price before the end of Define (pre FID)

Operations Readiness and Operational excellence

- Project success depends on early Operations input
- Initial operational input provided by existing technical staff
- The future Operations Director will be mobilized towards the start of FEED
- Energean adopts processes common with most IOC's

Contracting Strategy development

- Initial options already developed focus on lump-sum EPCI with major Alliance to mitigate execution risk for Energean
- Full Strategy will be developed during Select phase and subsequently refined
- Shell process employed for development of appropriate Strategies

Local Content obligations

- Limited Israeli requirements largely satisfied in operating phase and though environmental activities
- Little appetite of capability to be involved in construction phase
- Integration with existing industries maximizes opportunities

Risk Management

- HEMP based process for Risk identification and management (Business, Technical and HSE risks managed in a similar manner)
- Also used to identify and action opportunities

Environmental Assurance

- Energean builds on 35 years faultless performance in Greece
- Good understanding of Israeli requirements from work on Sarah
- Good local companies capable of managing all required works
- Legislation becoming progressively clearer



Project Control example: Contracting Strategy



ENERGEAN

OIL & GAS

Contracting Strategy: Deep water "Alliance" contractors





Conclusions



Conclusions

- The Karish and Tanin fields hold significant volumes of sweet biogenic gas
 - Greater than 3 Tcf GIIP (NSAI figure)
- Reservoir quality is "World Class"
 - Similar to Tamar and Leviathan
 - Wells can produce at prolific rates: >300 mm scf/day
 - Hence only a small number of wells are required
- Reservoirs are at high initial pressures (600 bar) and gas contains little impurities
 - Relatively simple processing requirements to achieve sales specification
 - With a modest aquifer high recovery factors can be achieved (>80%)
- The Karish field contains a significant volume of light, sweet oil
 - At a production rate of 300 mmscf/day, 8,000 bbls/day oil can be expected
- Energean plans to build upon its existing development and operational experience in Greece
 - Technically complex, pre-salt, high pressure stacked sour-gas and oil reservoirs
 - Management of extensive gas processing facilities
 - Environmentally sensitive location
- Energean will work closely with an established Deep-water EPCIC contractor
 - Facilitate transfer of skills to a deep-water setting



Thank you. Questions?



www.energean.com

Head Offices

Athens - Greece

32, Kifissias Ave. Atrina Center, 17th floor 151 25 Marousi Tel: +30 210 81 74 200 Fax: +30 210 81 74 299 e-mail: info@energean.com **Kavala - Greece** 64006 Nea Karvali P.O Box 8, Kavala Greece Tel: + 30 2510 317201 Fax:+ 30 2510 317204 United Kingdom 7B Abbey Road, NW8 9AA London UK Tel: +44 20 7286 6574

11

Cyprus 36, Vyronos 1506 Nicosia, Cyprus Tel: +35 722447444 Fax: +35 722447445

Egypt

Building 1 Square 1169 Mokarar Sheraton, Heliopolis Cairo, Egypt Tel.+202 22696484 Fax.+202 22696474