Soaring demand for LNG

▶ Operating LNG processing plants in Australia …
  • The North West Shelf LNG Project in Western Australia, five LNG trains with a total production capacity of 16.3 million tonnes per annum (mtpa)
  • The Darwin LNG plant single production train has a capacity of 3.6 mtpa
  • The Pluto project, single production train with a capacity of 4.3 mtpa

▶ LNG developments in construction…
  • The Chevron Gorgon Project, initial 3-train, production capacity 15 mtpa, ($42 billion) in WA, due for startup in 2014-2015

▶ Final Investment Decisions have been taken for…
  • The Chevron Wheatstone project, 2-train, production capacity 8.9 mtpa, ($29 billion) in WA, due to be operational in 2016
  • The INPEX Ichthys project, 2-train, production capacity 8.4 mtpa, ($34 billion) landing in Darwin, due to be operational in 2017
  • The Shell Prelude project (production capacity 3.5 mtpa), which will use Floating LNG technology, due to be operational by 2016-2017

▶ Other potential LNG projects
  • Browse, Equus, Pluto trains two and three, Sunrise, Bonaparte, Scarborough
The Chamber of Minerals & Energy of Western Australia warns *

- Critical shortages are occurring in many key professions, including geologists, metallurgists and engineers - all disciplines.
- The potential implications of such shortages include cost blowouts, missed deadlines, project delays and even project cancellations.

To address this shortage, the Chamber suggests… *

- A flexible skilled migration program to fill urgent gaps
- Increase workforce diversity with more women and indigenous employees
- Invest in training and skills development of the workforce

Addressing the shortage

- The Subsea Technology module at the University of Western Australia helps provide training and skills development

* Submission to the Senate Education, Employment and Workplace Relations Committee inquiry, 31st January 2012
Subsea Courses

- **Short Courses**
  - 1 week, five days attendance
  - Jee, or SUT Subsea Awareness Course

- **Fast track**
  - Lectures focussing on subsea hardware

- **Learning reinforced by site visits**
  - Factory and workshop visits

- **Extended Course**
  - 14 week, 1 night per week
  - UWA Subsea Technology Course

- **More relaxed pace**
  - Lectures about hardware and system design
  - Wider focus

- **Learning reinforced by the assignment**
  - Students formed into teams
  - Work together on a subsea development
Lectures on Hardware

- Tree and Wellhead Systems
- Subsea Structures and Manifolds
- Subsea Control Systems and Umbilicals
- Flexible Flowlines and Flexible Dynamic Risers
- Tie-In and Connection Systems
- Future Subsea Technology
Lectures on System Issues

- Subsea System Development
- Risk, Reliability and Availability
- Fabrication and Installation
- System Integration Testing and Commissioning
- Inspection, Maintenance and Repair
Case Studies

- The East Spar project
- The Norwegian Snøhvit LNG project
- The Woodside Angel project

- Cover the equipment and field layout selected
- Give justification for the choices made
- Are presented by lead engineers who worked on these projects
Assignment

- Students formed into teams on first night
- Assignment presented on first night
- Assignment comprises a subsea oil or gas field to be developed
- An immersive environment where the team members work together inside and outside class
- The teams show their work in a 20 minute presentation and a 40 page report
- The team work is marked by four engineers and an assessment is fed back to the teams

The assignment is the main differentiator of the UWA Subsea Technology course from other Subsea courses

- It provides a motive for learning and understanding the lecture material
- It provides an opportunity to use the information
- It provides experience of working together in a team
WA-368 – P “Perth Basin”

Yngling Prospect

Catalina 3D Seismic Survey

Prospect P10 Area

Prospect P90 Area

50km
WA-368 – P  “Perth Basin”

Line V82a-r-33

Top Cretaceous

Valanginian Breakup Unconformity

Source Rock

Yngling Prospect

Top Reservoir 1.2

TWT sec

West

East 4.0

Charlotte 1
An oil company has a licence to drill off Rottnest Island - and exploration could go ahead within six months.

Melbourne-based Nexus Energy holds an exploration permit covering almost 2000sqkm from Rottnest to Quinns Rocks in Perth's north. Federal Resources Minister Martin Ferguson confirmed this week.

At its closest point, the lease is just 10km from Rottnest Island and 10km from Perth's northern beaches, including Scarborough, North Beach and Hillarys.

The area could hold as much as 200 million barrels of oil, according to the company.

And Nexus Energy managing director Richard Cottee said if exploration went ahead, the drilling rig would be clearly visible from Rottnest and Perth beaches.
Reserves and Extraction Rate

Yngling
Recoverable Reserves
80 MMbbl

Stybarrow 61 MMbbl
Enfield 52 MMbbl
North Rankin 150 MMbbl

Extraction Rate
Mutineer-Exeter (2007)
11.1 MMbbl/year = 30,000 bbbl/day
Enfield (2007)
17.1 MMbbl/year = 47,000 bbbl/day

Extraction Rate
30,000 bbl/day
7.3 years

Extraction Rate
60,000 bbl/day
3.7 years
Production Decline and Watering Out

# TABLE OF CONTENTS

1. INTRODUCTION .................................................................................................................. 3  
   1.1 General .......................................................................................................................... 3  
   1.2 History ......................................................................................................................... 3  
   1.3 Geology ....................................................................................................................... 6  
   1.4 Prospects ..................................................................................................................... 6  
   1.5 Field Location ............................................................................................................. 7  
   1.6 Design Intent .............................................................................................................. 7  

2. FIELD DESIGN PARAMETERS .......................................................................................... 9  
   2.1 Design Life .................................................................................................................. 9  
   2.2 Availability ............................................................................................................... 9  
   2.3 Hydrate Prevention and Remediation ....................................................................... 9  
   2.4 Corrosion Inhibition ................................................................................................. 9  
   2.5 Gas and Water Disposal ........................................................................................... 9  
   2.6 Well Test ................................................................................................................... 9  

3. SUBSURFACE AND WELLS ........................................................................................... 10  
   3.1 Reservoir Data .......................................................................................................... 10  
   3.2 Well Productivity ........................................................................................................ 11  
   3.3 Xmas Trees ............................................................................................................... 11  
   3.4 Drilling and Type of Wells ....................................................................................... 11  

4. FLUID PROPERTIES ....................................................................................................... 12  
   4.1 Well Test Data .......................................................................................................... 12  
   4.2 Produced Oil Properties ............................................................................................. 12  
   4.3 Produced Water .......................................................................................................... 12  
   4.4 Crude Viscosities ....................................................................................................... 13  
   4.5 Hydrate Properties .................................................................................................... 13  

5. METEOCEAN AND ENVIRONMENTAL ......................................................................... 14  
   5.1 Water Depth ............................................................................................................. 14  
   5.2 Metocean Conditions ............................................................................................... 14  
   5.3 Variation of Water Temperature with Depth ............................................................ 14  
   5.4 Soil Conditions ......................................................................................................... 14  
   5.5 Environmental .......................................................................................................... 14  

6. COSTING AND SCHEDULE ......................................................................................... 14  
   6.1 Costing ....................................................................................................................... 14  
   6.2 Schedule .................................................................................................................... 14  

7. APPENDIX - CONVERSION FACTORS ........................................................................ 15  

8. APPENDIX - COST DATABASE / RELIABILITY DATA ................................................ 17
Field Layouts proposed by the teams

- **Team 1** - 3-6 production wells, 2 water injection, 2 gas injection
  - FPSO in 43 metres, dual flowlines
  - Dual ESPs (Electrical Submersible Pumps) in each well

- **Team 2** - 4-8 production wells
  - Subsea to Beach (51km offshore pipeline and 30km onshore)
  - Three booster pumps

- **Team 3** - 4-6 production wells
  - Remote FPSO in ~100 metres, single flowline
  - Natural flow

- **Team 4** - 12 production wells, 3 water injection, 1 gas injection
  - Remote FPSO in ~140 metres, dual flowlines
  - Dual subsea booster pumps
Feasibility

• Does it work?
  – Production Profile
  – Pressure drop calcs and flowline sizing
  – Reliability

• Is it a cost effective solution?
  – CAPEX and OPEX

• Have the problems been identified – and solved?
  – Low reservoir pressure – needs boosting
  – Wax present
  – Preventing pollution of beaches
  – Difficult seabed – sand and limestone pavements
  – The SE-ME-WEA-3 telecommunications cable
  – Visibility from shore

• With bigger teams, these issues could be fully worked…
INTEC Excellence Award
for Best Master of Oil and Gas Engineering Team Project in Subsea Technology
2011 winners are Team 2
Design focus

Team 2 Energy’s key design drivers are:

- ZERO visual impact
- Minimise offshore inventory of oil and chemicals – no offshore storage
- Use well established technology with proven reliability and environmental performance
- Use existing facilities/infrastructure where practical
- Minimise CAPEX and OPEX
Concept Selection

Selection Process

■ Develop Concepts.
  1. Drilling
     ○ Template vs Cluster vs Satellite
  2. Production Facilities
     ○ Fixed Platform vs FPSO vs Tie-back to Shore
  3. Controls
     ○ From production facilities vs remote (control buoy)

■ Concept Workshop for Screening against project drivers
Field Development Overview

Constraints

Reservoir “Hot Spots” to be Targeted

Submarine Cables to be Crossed

Marine Parks Considered “No-Go” Areas (in Green)

Shipping Channels Considered “No-Go” Areas (in Red)

Industrial Zoning (in Purple) Targeted for Processing Facilities
Field Development Overview

Field Development

- **2 x 4-Slot Manifolds with Deviated Wells**
- **Cable Crossing**
- **51km Insulated Carbon Steel Pipeline**
- **15km Rock Berm**
- **2km HDD Shore Crossing**
- **30km Onshore Pipeline to Kwinana**
- **Production Fluids Delivered to BP Kwinana**

Yngling Field Development Team 2 Energy
Pressure profile

- Pipeline drop
- Wellbore drop
- Driving pressure supplied

Pressure (bar)

Years

Yngling Field Development Team 2 Energy
Flow Assurance

- **Pipeline**
  - 12 inch carbon steel pipeline
  - Coated with concrete
  - Cathodic protection on connections
  - Treated with corrosion inhibitor
  - Equipped with corrosion monitor

- **Hydrate**
  - Insulate pipeline to be in hydrate free region
  - No continuous methanol injection
  - Inject methanol in transient operations (i.e. startup and shutdown)

- **Wax**
  - Insulate pipeline 15°F above WAT
  - Inject wax inhibitor when flow rate is low
  - Pigging at the optimum frequency

- **Asphaltene**
  - Inject inhibitor continuously
  - Pigging at the optimum frequency

- **Scale**
  - Analyze water sample
  - Inject scale inhibitor continuously

- **Sand**
  - Use sand screen at down hole
  - Use acoustic monitor to inspect the appearance of sand
Template-Manifold

Yngling Field Development

Team 2 Energy

Connectors
Gate Valves
MSCM
MEG
XT + Choke
Manifold Primary Piping
Manifold Secondary Piping
Instrumentation
Multiphase flowmeter
Pressure & Temp Logger
Sand Detector

From SDU

10 meter

12 meter
Controls and Umbilicals

Overview of the Control System

Decisions:
- EH-Mux control system
- Open hydraulic system
- Includes hydraulic accumulator module
- Each tree has an SCM
- Combined power distribution module
- Chemical distribution module
- Weak link

Dual Redundant Systems (1):
- Dual MCS with cross-over
- Dual channel EPU
- Duty and standby pumps for LP and HP hydraulics
- Dual HP and LP paths (umbilical)
- Dual signal paths (umbilical)
- Dual power paths (umbilical)
- Dual power supply (SCM)
- Dual signal paths (SCM)

Health, Safety & Environment

Our Philosophy

- Do no harm to:
  - Our People
  - Our Environment
  - Our Community
Project Economics

- **Total Revenue**: $4483M
- **Government take**: $1359 M
  - NPV $623M @ 10% discount
- **Contractors take**: $1849 M
  - NPV $796 M @ 10% discount
- **IRR**: 47.2%

---

**Yngling Development: Contractors' Cash Flow**

- 2003: (131) millions
- 2004: (197) millions
- 2005: 124 millions
- 2006: 530 millions
- 2007: 610 millions
- 2008: 418 millions
- 2009: 256 millions
- 2010: 140 millions
- 2011: 96 millions
- 2012: 69 millions
- 2013: 51 millions
- 2014: 39 millions
- 2015: 30 millions
- 2016: 23 millions
- 2017: 18 millions
- 2018: 14 millions
- 2019: 7 millions
- 2020: 5 millions
- 2021: 4 millions
- 2022: 3 millions
- 2023: 3 millions

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**Yngling Development: Government's take (Royalty + Tax)**

- 2004: 70 millions
- 2005: 281 millions
- 2006: 210 millions
- 2007: 107 millions
- 2008: 91 millions
- 2009: 63 millions
- 2010: 45 millions
- 2011: 26 millions
- 2012: 21 millions
- 2013: 17 millions
- 2014: 13 millions
- 2015: 9 millions
- 2016: 7 millions
- 2017: 5 millions
- 2018: 4 millions
- 2019: 3 millions
- 2020: 3 millions
Summary

Our design results in:

- Zero visual impact
- Minimal offshore inventory of oil and chemicals – no offshore storage
- Using existing facilities/infrastructure where practical
  - existing North Fremantle tank farm for chemical injection storage and pumping
  - pipeline easement between Kwinana and North Fremantle
  - BP refinery
- Using established technology with proven reliability and environmental performance
The only footprints you’ll see
Field Layout

Team 1

Submarine Cable Protection Zone
Field Development Overview

Field Development

- 2 x 4-Slot Manifolds with Deviated Wells
- Cable Crossing
- 51km Insulated Carbon Steel Pipeline
- 15km Rock Berm
- 2km HDD Shore Crossing
- 30km Onshore Pipeline to Kwinana
- Production Fluids Delivered to BP Kwinana
- Onshore Pipeline to Kwinana
- Infield Subsea Facilities

Yngling Field Development

Team 2 Energy

Slide 34
The diagram depicts the field layout with various components:

- **Umbilical line**
- **10 km 12” Carbon Steel pipeline**
- **Flexible jumpers**
- **Production well**

### Key Components:

1. **Umbilical line**
2. **10 km 12” Carbon Steel pipeline**
3. **Flexible jumpers**

### Important Notes:

- **Rottnest Island**: 28 km
- **Reservoir A**: 50 km
- **Reservoir B**: Approx. water depth in this area is 46 m
- **Production well**: Placed at a water depth of 42 m
- **PLET**: Placed at 100 m water depth
- **5 Km 12” flexible pipeline and riser**
- **Umbilical pipeline**
- **Junction Box**: Used for connecting different components
- **Rigid Jumper**: Used for connecting components at specific water depths

### Distances:

- **28 km**: Distance from the production well to Rottnest Island
- **50 km**: Distance from Reservoir A

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**Team 3**
The UWA Subsea Technology course

- Students and people from industry gain an appreciation of subsea equipment
- Participants appreciate the issues involved in putting together field layouts
- Participants experience working together in a team on the development of a subsea system design