Assessment of the Engineering Design Capability and Capacity in the Oil and Gas Sector in Western Australia

GOVERNMENT OF
WESTERN AUSTRALIA

Assessment of the Engineering Design Capability and Capacity in the Oil and Gas Sector in Western Australia

Report for the Department of Commerce

Report prepared by Dr. Martin West

September 2011

Executive Summary

This study focuses on the oil and gas sector in WA and in particular LNG and covers the following components:

- Trends and impacts on engineering and design in Western Australia.
- An assessment of cost competitiveness of Western Australia in comparison with offshore engineering and design services for resource projects.
- An assessment of the capacity of Western Australia to undertake engineering and design for resource projects.
- An assessment of Western Australia's perceived profile, reputation and track record on a world scale.
- An assessment of the inherent advantages and disadvantages, strengths and weaknesses of sourcing design and engineering services in Western Australia.
- Identify and examine barriers to Western Australia taking advantage of future engineering and design opportunities from major resource project work.
- Possible role of Government to overcome some of the barriers.

The project methodology included a number of activities. As a first step, a substantial literature review was undertaken to identify issues and trends facing engineering design in oil and gas projects. An analysis was also undertaken of relevant statistics compiled by various government agencies. These are presented in Appendix C. Following the literature review, a questionnaire was developed and administered online; targeting engineers working in the industry. Another questionnaire was sent to a number of companies active in the oil and gas industry. Subsequently, a number of key senior stakeholders were interviewed.

The online questionnaire has been very successful with 402 usable responses. The respondents are representative of all major sectors of the industry, including resource developers, EPCM/EPC companies, consultants and other sectors. The respondents are also very well qualified with the majority having a degree or better. They are also very experienced with more than 70% of respondents having more than 10 years industry experience.

The company questionnaire was less successful with only 25 responses. A copy of the questionnaires are provided in Appendix A and B.

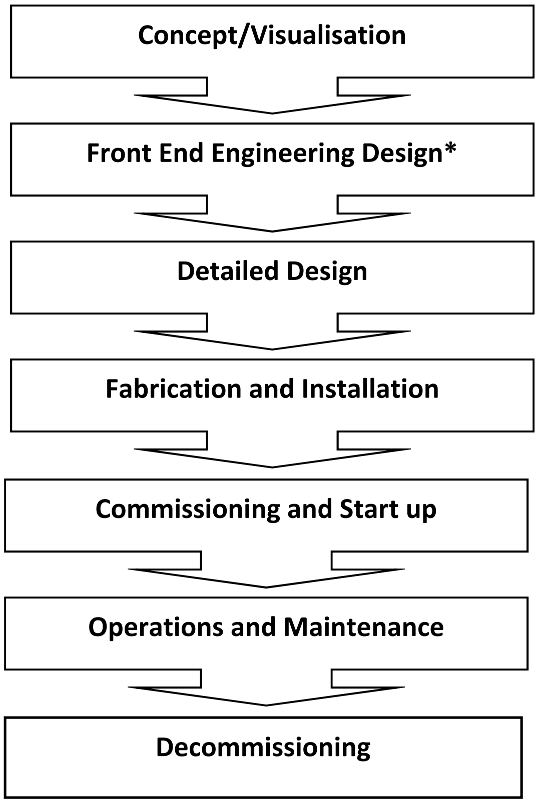
Background on Engineering Design

It is best to understand engineering design within the context of project phases

Project Phases

LNG projects (and other large engineering projects) generally follow a number of phases. These phases are sometimes called different names by different proponents but are generally as indicated in the figure below.

Figure A: Project Phases



*Final Investment Decision (FID) generally takes place after FEED but in more complex projects this is sometimes delayed until part of the detailed design has been completed.

For the purpose of this project the focus is on the first three phases. These are discussed below.

Concept / Visualisation

The concept / visualisation phase starts after a resource has been discovered. Activities in the concept / visualisation phase include identification and scoping where various initial concepts and options are considered, preliminary cost estimates are undertaken and initial risk assessments are completed. The objective of a concept study is to strategically review a number of alternative project schemes to give sufficient information to enable a go or no-go decision on whether to progress the most promising development pathway.

Front End Engineering Design (FEED)

FEED follows the initial concept phase. It is undertaken to analyse the various technical options for new development with the objective of more clearly defining the project.

FEED phase includes pre-feasibility (sometimes this is included in concept phase), feasibility and bankable feasibility studies. During FEED a workable process design is generated, project costs are analysed, systems are identified and the initial plot layout is proposed. During FEED an engineering solution is developed with sufficient detail to enable a ±20 per cent cost estimate to be established. Additionally, the project schedule is further developed and often commercial contracts are being

prepared.FID is generally based on the FEED but in more complex projects this is sometimes delayed until part of the detailed design has been completed.

Detailed Design

Following FEED, detailed design is undertaken. The focus is on designing all project elements to sufficient detail so that these can be fabricated and constructed. The project team takes the FEED design and implements rigorous design calculations, safety and environmental auditing, interdisciplinary review and operability checks. The workload rises as numerous documents and information are transferred between parties. This is the busiest time in the design phase of the project. A large number of people are involved in the detailed design phase. Depending on the project, this can be more than 400 design engineers and draughts people.

Macro Trends Impacting on Engineering Design

There are a number of macro trends which impact on the ability for WA to develop engineering design expertise. These include the following:

Increasing Importance of Natural Gas as Energy Source

As the world population increases and more and more people and countries urbanise and industrialise, the demand for energy will increase. The IEA estimates that the world demand will increase by 45 per cent from the current levels. This equates to 1.5 per cent increase per annum, which is higher than the expected population growth. Given the green credentials of gas it will continue to grow in importance as energy source. It will be the third most important energy source behind oil and coal.

Cost Pressures

Costs of LNG projects have increased over the past few years for a number of reasons. These include increased complexity to get to the raw material, limited availability of EPC/ EPCM contractors due to high number of projects worldwide, high material prices including steel, lack of skilled and experienced workforce, exchange rate, etc.

Increased complexity and new technologies

LNG projects are becoming increasingly complex as the need increases to search for new gas sources in more hostile environments. Similarly, cost and other pressures require the development of different technologies which all in turn have an impact on engineering design requirements.

Emergence of Engineering, Procurement and Construction Managers (EPCM)

Resource owners are increasing using Engineering, Procurement and Contract Management (EPCM) companies. Under the EPCM model the contractor does no building or construction, rather they manage the design and construction on the owner's behalf.

This trend impacts on WA design engineering, as resource developers can use a firm located anywhere globally to manage their design as well as the remainder of the process, with more emphasis being placed on risk avoidance by choosing EPCMs with experience and access to proprietary technology. This trend also impacts WA industry as a whole in that the location of the EPCM contractor often influences the location of subsequent fabrication. EPCM's often have arrangements with suppliers and/or fabricators of choice who they have alliances or partnerships with and who they use regularly.

Modular Construction

Modularisation refers to the pre-fabrication and pre-assembly of a complete system away from the job site which is then transported to the site. Modularisation can be done in components as site-specific needs dictate. For example; prefabrication, preassemblies or packaged / skidded components all fall under the umbrella of modularisation.

This trend towards modularisation is impacting Western Australia's chances to attract FEED and detailed design opportunities as it is easier for companies to create the designs in the locations in which they will be manufactured. Modules that are prefabricated and shipped as they are required by firms have less need of individual design, and scheduling is easier to control by keeping all processes in one location, such as Malaysia, where some of the major construction yards are located.

Internationalisation of Supply Chains

As with supply chains of other industries, the supply chain in the oil and gas (LNG) sector is increasingly being internationalised. This implies that the various activities in the supply chain that are footloose are undertaken in the part of the world where it makes the most commercial sense to do so. That is, activities are undertaken where it best meets the requirements of available expertise, cost, project schedule, risk management, technology and so forth.

The internationalisation of the supply chains is increasingly impacting on design services. Detailed design is increasingly commoditised and moved to appropriately skilled and low cost centres with sufficient resources. These include India, Thailand, China and South Korea. Similarly, Initial and front end design is undertaken by EPCM companies where it is most appropriate for them. This is to some extend driven by costs but also by the availability of highly skilled staff and the need to have a project design pipeline to ensure continued engagement of their staff. This includes centres such as Houston, Reading and Yokohama.

For WA to become a major player in the engineering design area it will not only have to be internationally competitive in terms of price, quality and expertise but also will have to ensure a sufficiently robust pipeline of design opportunities.

WA Capability, Capacity and Competitiveness

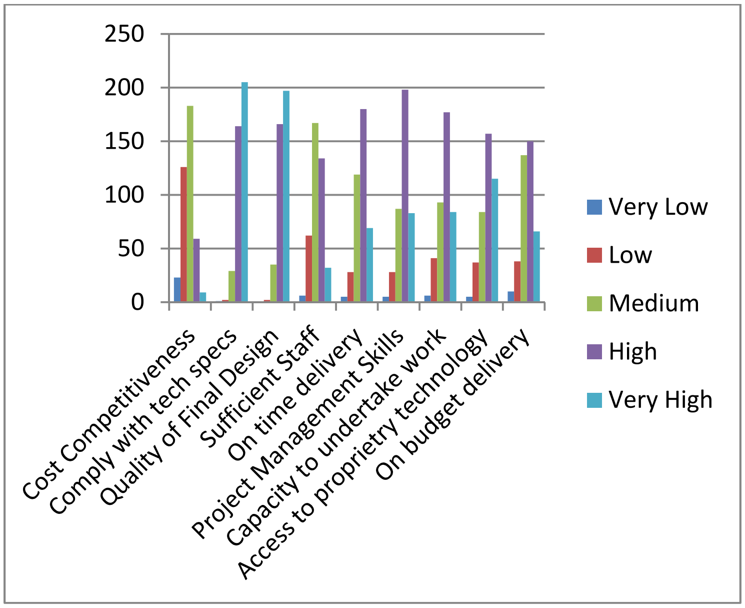
This section focuses on assessing WA's LNG design capability, capacity and competitiveness.

Overall Assessment

As a starting point for assessment of WA's capability, capacity and competitiveness a range of factors have been identified through literature reviews and discussions with industry experts. Respondents to the online questionnaire were asked to rate WA against these factors on the scale of: Very Low, Low, Medium, High and Very High.

The figure shows that there is general consensus that WA does well in terms of quality of design and compliance with technical specifications. However, there is also consensus that WA is not cost competitive and that there are not sufficient numbers of appropriately qualified people.

Figure B: Assessment of WA Overall Competitiveness

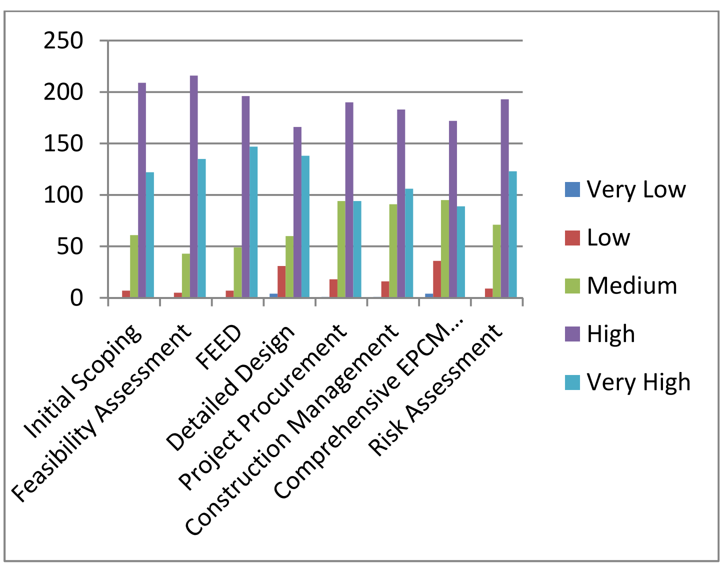


Capability Related to Key Project Phases

An assessment of WA's capability has been undertaken focusing on the key project phases. This provides an overall perspective of the capacity and capabilities. The results from the online survey are shown in the figure below.

The overall figure shows that the general view from the respondents are that WA has high to very high capabilities in most phases of a large gas project. The scores are the highest in initial scoping, feasibility studies and FEED. In none of the phases is there a view that WA has overwhelming low or very low capability. Two areas have somewhat lower scores and these are detailed design and comprehensive EPCM services.

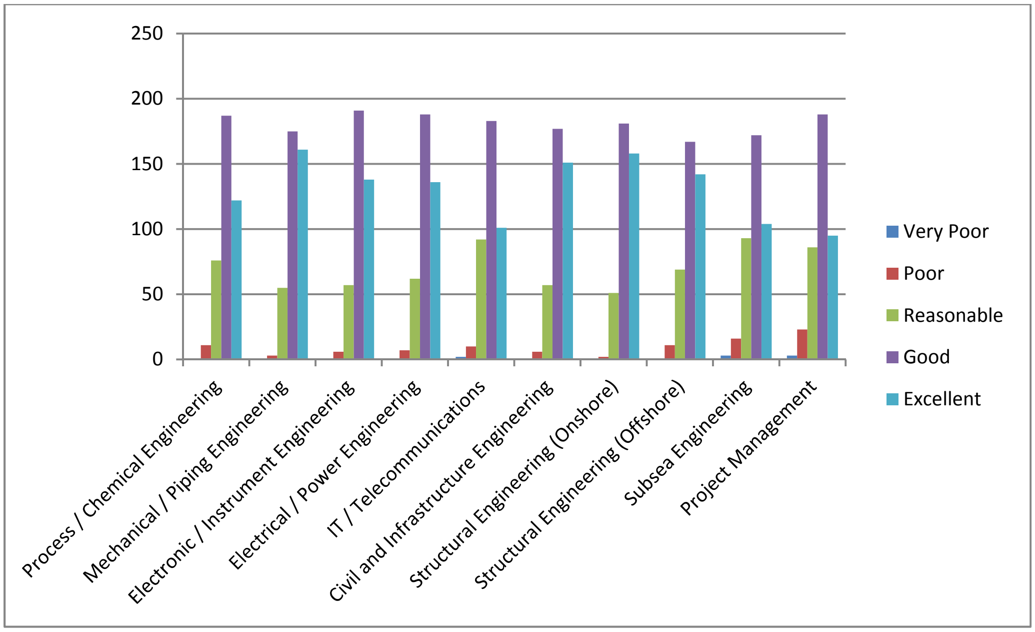
Figure C: Assessment of WA Capability Related to Key Project Phases



Discipline Capability

There are a number of engineering disciplines which are important to undertaking engineering design and execution of large scale oil and gas projects. The required expertise is wide ranging and varied. The results are shown in the following figure.

Figure D: WA Discipline Capability

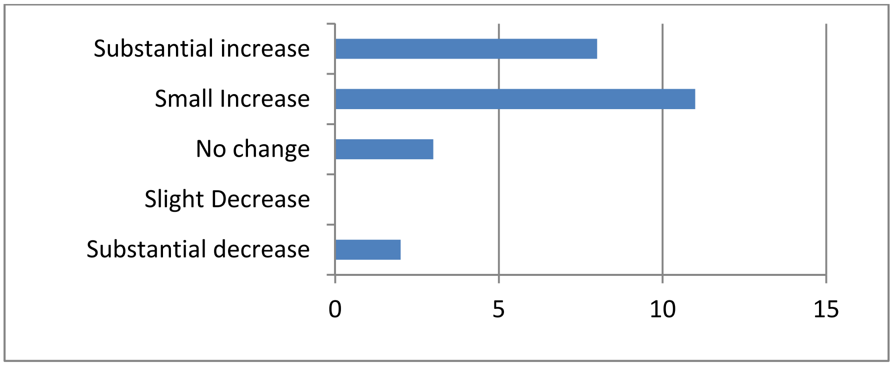


Capacity

The design capacity in the industry has been explored in a number of ways. In the first instance, an analysis was undertaken of officially available data. Although some data are available related to the oil and gas industry in WA, none provide substantial insight into the design capability. Given the marginal relevance, the analysis is provided in Appendix C.

The capacity in the industry has been further explored through the company questionnaires. Companies were asked about their intention regarding recruitment of engineers in the oil and gas sector. The results are shown below. It shows that most companies are planning to have a small or substantial increase in engineering capability.

Figure E: Company Intentions to Employ Additional Professionals



Assessment of WA's International Profile

In a further assessment of the WA's profile, questions were asked about how WA compares with the world's best. This provides an international context of WA's capabilities and capacities. Respondents were asked to compare WA with the world's best based on a range of issues. The results are shown below.

Figure F: International Comparison of WA's Overall Technical and Engineering Expertise

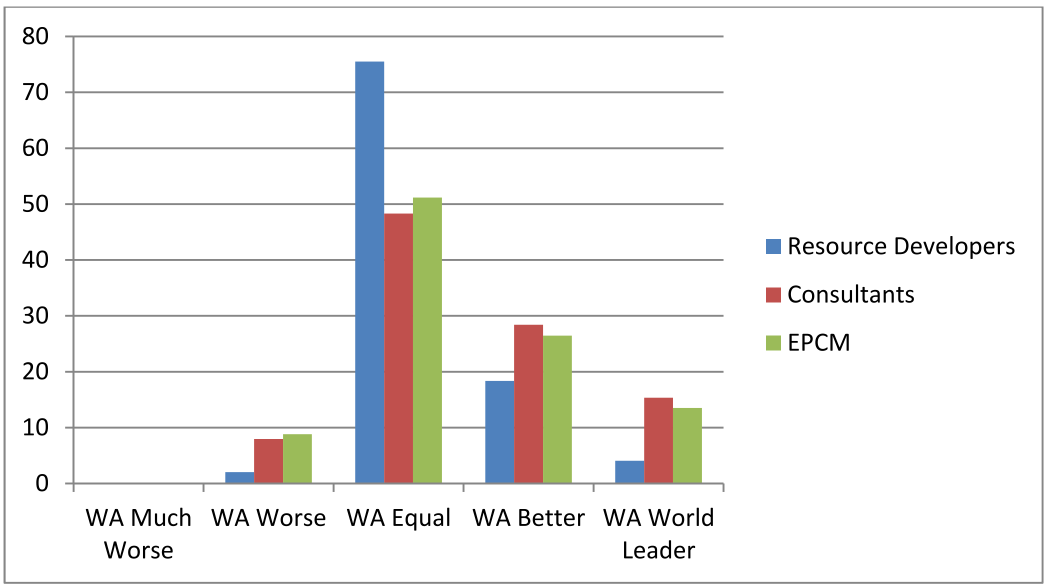


Figure G: International Comparison of WA's Capability to undertake FEED

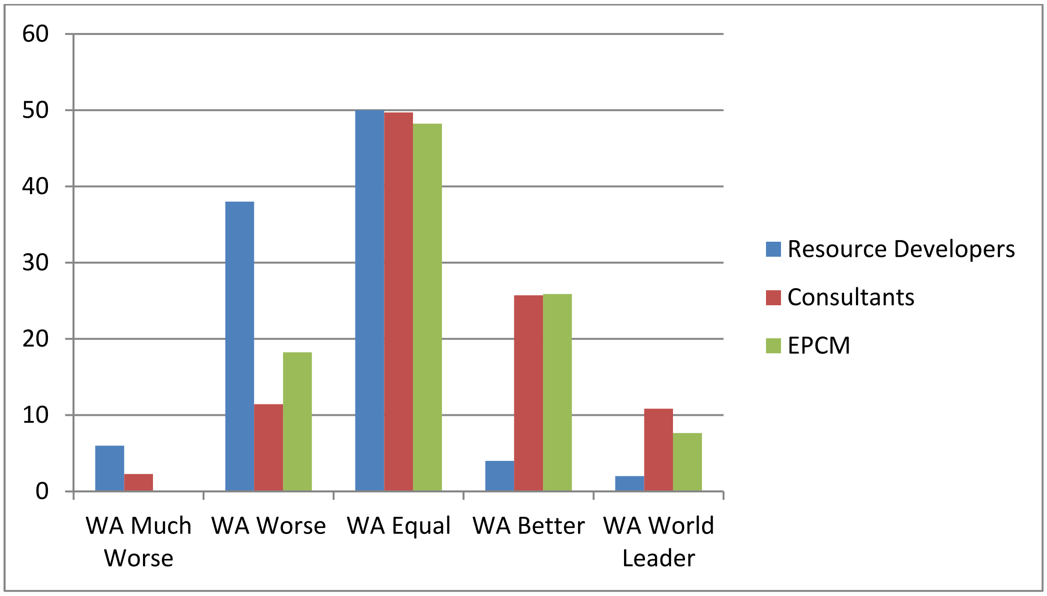


Figure H: International Comparison of WA's Capacity to undertake FEED

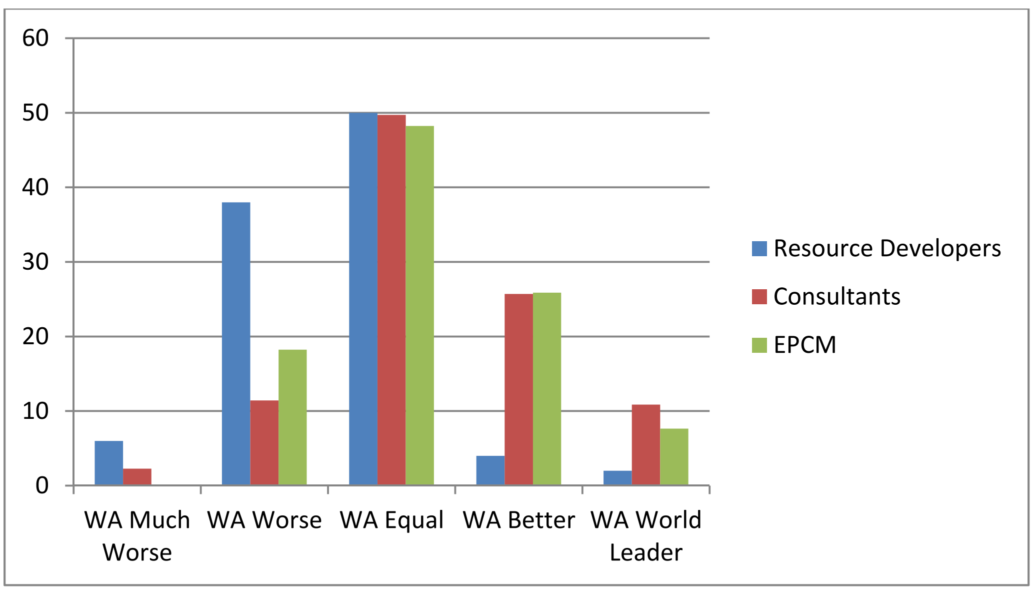


Figure I: Average Salaries for Permanent Staff

Policy Considerations

This section provides some policy considerations in relation to high end engineering design in WA. It first summarises the key drivers which are likely to impact on the WA engineering design sector in the foreseeable future. Most of these drivers are based on the strengths and weaknesses of the WA engineering design industry combined with likely barriers to future development. It then provides some policy options to enhance engineering design in WA.

Key Drivers Supporting Development of High End Engineering Design in WA

- Gas and in particular LNG will be an increasingly important source of energy in the foreseeable future.

- LNG projects will become increasingly complex (and more expensive) due to the need to explore for gas in deeper waters and in more remote locations. This will require more specialised skills and resources. Large projects also have a very long project cycle which sometimes could be ten years from first exploration to production. Up front deterrents should therefore be minimised.

- As projects become more complex, front end work will become more important to carefully assess project economics and to inform FID.

- WA has close geographic proximity to large gas fields and is also relatively close to key customers. Being in the same time zone as Asia makes it easier to interact.

- The skills and competencies of WA engineering professionals are highly regarded internationally.

- The initial stages of a project up to FEED are relatively small components of the overall project expenditure- typically around 2-3 per cent. These stages require highly skilled and experienced engineers and drafts people. WA/Australia is capable of providing those services although some supply constraints exist.

- Commonwealth / State Government policies are not seen as inhibiting the development of WA as a design centre. Governments are stable with clear processes and low sovereign risk.

- WA/Perth offer exceptional lifestyle.

- WA has reasonable education / training and research and development facilities although there is scope for enhancement of these facilities.

- Industrial relations considerations are not significant in a highly skilled environment such as engineering design.

- WA, combined with the remainder of Australia, has a substantial pipeline of gas related projects.

Key Drivers Working Against Development of High End Engineering Design in WA

- Technology specialisation and supply chain internationalisation will result in the development of limited key supply bases where maximum comparative advantage can be achieved.

- WA currently lacks the critical mass of other design centres such as Houston and London.

- Australia and WA's record in oil and gas project delivery has not been good with substantial time and cost overruns; this impacts on the perception of the whole sector including high end design.

- The development of FNLG technology can have substantial negative impact on WA given the territorial boundaries between the State and Commonwealth Governments.

- Australia/WA is now regarded as a high cost centre. This is mainly the result of the exchange rate but this is important as most transactions in oil and gas projects are transacted in US$. There is a clear trend to do as much work as possible overseas due to cost and associated factors.

- Industry is experiencing some difficulty in recruiting skilled engineers and this is likely to continue in the near future. There is strong competition with the mining sector for highly skilled engineers in some areas.

- Detailed design is increasingly commoditised and undertaken in specialised low cost centres. WA can no longer compete in that market.

- As projects become more complex, resource developers align more with well-known and trusted EPCM companies which they have worked with previously.

- Propriety technologies are important in LNG project development and form the basis of FEED. These technologies are often associated with particular international EPCM companies, limiting choice to those companies with access to the required technology.

- There are well established oil and gas engineering design centres worldwide which align with major EPCM companies' operations and centres of excellence.

- Commonwealth / State Government policies to attract and retain experienced professionals are not as aggressive as competing governments.

- Individual tax rates are seen as relatively high compared with other countries.

- Currently FEED is undertaken by international design houses and unless FEED is poorly executed, detailed design will often remain with the FEED provider therefore providing limited opportunities for WA / Australian companies.

Potential Policy Considerations

The primary conclusion from the discussion above is that WA has some key advantages in developing engineering design capabilities. It also faces some substantial drivers against promoting engineering design capabilities.

The key take-aways are that:

- WA does not have the capacity to be competitive in detailed design. If any focus is to be placed on design capability in WA it should be on pre-FEED and FEED. WA has the capability to undertake FEED. Some concerns have been expressed about the capacity.

- Activities up to FEED are only a small proportion of a project, typically no more than 2-3 per cent of overall project expenditure. Additionally, FEED only requires a relatively small number of highly skilled professionals. For a typical project it can be 200-300 professionals.

- FEED related expenditure has little impact on the project economics but undertaking FEED well has major impact on project outcomes.

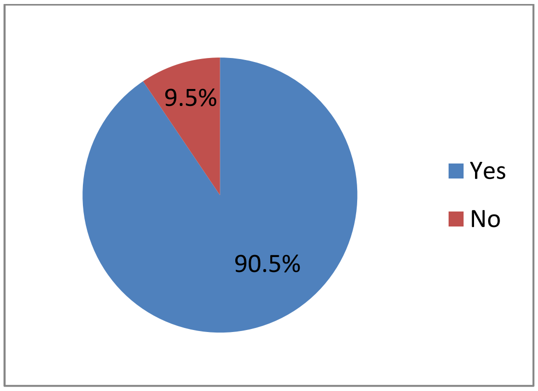
- There is some correlation between where FEED is undertaken and location of subsequent activities. Localisation of FEED can therefore be a catalyst for other local benefits. It has substantial flow on benefits.

- The overall trend in terms of FEED is against WA and substantial ground has been lost. It will take substantial effort to turn the tide around. Given industry trends, relationships and past records it is only through substantial government intervention that this trend will be reversed.

To date negotiations between government and project proponents have had limited success in securing FEED for WA. Since Woodside train 4 there has been limited design undertaken in WA, despite a number of large projects being developed or currently in the pipeline. The overall assessment from industry is that in terms of engineering design, WA has gone backwards.

There is strong desire by industry that the Government should do more to ensure that high end engineering design is undertaken in Perth. There is an overwhelming support for government mandating FEED to be undertaken in WA. Responses to an online question about mandating are shown in the figure below, where 90.5% of more than 400 respondents support government mandating design to be undertaken in WA.

Figure J: Should Government mandate that FEED be undertaken in WA?



Given that the initial high end design up to FEED is very specialized, requires relatively small numbers of highly skilled professionals, is only a small portion of the overall project expenditure and WA has highly skilled human and supporting resources, it can be argued that a special focus on FEED is warranted.

Recommendation 1: During the negotiation with project proponents, Government should have a specific focus on pre-FEED, FEED and associated project management activities and securing these to be undertaken locally.

Although industry supports mandating, a similar positive result should be able to be achieved through appropriate negotiations. Additionally, the use of different approaches such risk sharing or providing incentives should be considered. Incentives could include concessions in relation to research and development, the domestic gas requirement, payroll tax, reduction in royalties or import duties (as through the EPBS scheme) or even income tax reduction as currently being used by other countries.

If it is agreed that FEED should be a substantial focus then it follows that government should proactively ensure that the supply of highly qualified engineers is sufficient. Appropriate education and training and demand driven research and development should be encouraged. WA-ERA could be considered as a mechanism to make this happen.

Recommendation 2: Initiatives be undertaken by both Government and industry to ensure a sufficient supply of highly qualified and experienced design engineers and supporting professionals. These should include education / training as well as demand driven research and development.

Any policy considerations associated with FEED should be undertaken within the overall policy related to local content. The WA government has undertaken a range of initiatives to support local content in general and to improve WA performance relating to engineering design. These include commitment to the principle of full, fair and reasonable opportunity for competitive local suppliers to participate in WA resources projects; Australian Industry Participation Scheme (through Commonwealth Government), State Agreement Acts and the recently announced WA Government Local Industry Participation Framework. The WA Parliament also recently published a discussion paper by the Economics and Industry Standing Committee on The Potential for the Development of a Centre of Excellence in LNG Industry Design in WA.

On a basic level the Government's approach has been to provide an environment which is conducive for private sector to engage in the economic activity of extracting oil or gas (or other minerals). The private sector pays for this privilege through various royalties and taxes. To provide more local benefit the government negotiates with project proponents to achieve a level playing field for local industry.

The Government has recognized that this approach can be improved and has recently launched the WA Government Local Industry Participation Framework. This is a ten point framework based on a broader definition of local content to also include: research and development, regional initiatives, indigenous programs, community support, facilitation of technology transfer, joint ventures, training and skill initiatives and the encouragement of local suppliers into international markets. It also includes increased dialogue between resource owners and government.

Industry cites the success of other governments in securing not only design but also a range of benefits for the local economy. The recent Hebron agreement between the Government of Newfoundland and Labrador in Canada and project proponents (Chevron) is often quoted. The Provincial Government has a view that: 'if it has been built here before, then it can be built here again, if it is started here then it is completed here, and if it is built here, then it is engineered here'. After negotiations the Government extracted substantial agreement which include:

- 4.9% equity stake of the project and profits.
- Additional super royalty of 6.5% on top of the standard 30% to be paid if the oil price rises above US$50 per barrel.
- Fabrication shall take place in the province.
- Minimum of 1.2 million person hours of detailed engineering design work.
- Minimum of 1 million person hours project work to take place in the province.
- US$120m in research and development to be spent in the province.

Although recent initiatives by the State Government are considered steps in the right direction there does not appear to be an overall strategy which could provide an appropriate context for FEED related policy initiatives.

Recommendation 3: That policy initiatives related to FEED be contextualized within an overall industry development strategy for Western Australia.

One of the major issues raised by industry is that the relations between State and Commonwealth Governments often make for ineffective negotiations and outcomes. There is some evidence (from Canada) that a board comprising of both Governments (State and Commonwealth) and negotiating on behalf the two Governments, can be very beneficial in securing maximum local content.

In Canada the proponent is required to create a development plan which has to include a benefits plan and this has to be approved by the board. The benefits plan forms the basis of leverage over the proponents.

An alternative is to establish an expert advisory body which could advise the Minister on local content and industry development issues.

Recommendation 4: That Government considers the appropriateness of a local content board or expert advisory panel which could advise the Minister on local content and industry development issues.

FNLG is a key technology change which is likely to have a substantial impact on the industry. Opportunities in this regard are immense and it is possible for WA to become a global centre of excellence.

Recommendation 5: That the WA Government considers the need to take immediate action to facilitate the establishment of global centre of excellence in FNLG in WA.

Table of Contents

List of Figures and Tables

Abbreviations

AIPP	Australian Industry Participation Plan
EPBS	Enhanced Project By-Law Scheme
EPC	Engineering, procurement and construction
EPCM	Engineering, procurement and construction management
FEED	Front end engineering and design
FID	Final investment decision
FLNG	Floating Liquid Natural Gas Train
FOB	Free on Board
HSE	Health, safety and environment
IRR	Internal rate of return
IOC	International Oil Companies
LNG	Liquid Natural Gas
Mtpa	Million metric tons per annum
OHS	Occupational health and safety
RD	Resource Developers
WA	Western Australia
WA-ERA	Western Australia Energy Research Alliance

Section 1 - Introduction

The Oil and Gas sector in Western Australia (WA) is going through a significant boom period with an estimated A$185billion of projects currently being undertaken or in the planning stages. These projects provide substantial opportunity for involvement of WA industries and services.

WA holds substantial potential as an LNG supplier to Asian markets. Although WA has been an LNG exporter since the 1989 start-up of the Northwest Shelf Venture, this decade promises an unprecedented boom. There's already almost 20 Mtpa of new LNG export capacity under construction, and more than 72Mtpa of liquefaction capacity in the planning stage.

WA petroleum exports, including oil, condensate, LNG and liquefied petroleum gas (LPG), were worth more than A$18.5 billion in 2010, a 40 per cent increase on 2009.

Some engineers and other stakeholders in Western Australia have expressed a view that engineering design work for energy projects is increasingly going overseas, despite the availability of expertise and capability in Western Australia. Conversely, project proponents cite a lack of specialist engineering expertise, a thin labour pool and risk minimisation as reasons for engaging, for LNG projects, Engineering Centres of Excellence located in the United Kingdom (Reading), USA (Houston) or Japan (Yokahama).

These centres will also design work packages around globally recognised or well established overseas suppliers, thereby making it more difficult for local industry to compete. If this trend continues it has the potential to negatively impact not only local engineers but also on second and third tier industry in Western Australia, in particular local manufacturers.

Given these trends, the Department of Commerce commissioned this study to undertake an assessment of the WA engineering and design capability and competitiveness.

Purpose

This study focuses on the oil and gas sector and in particular LNG and covers the following components:

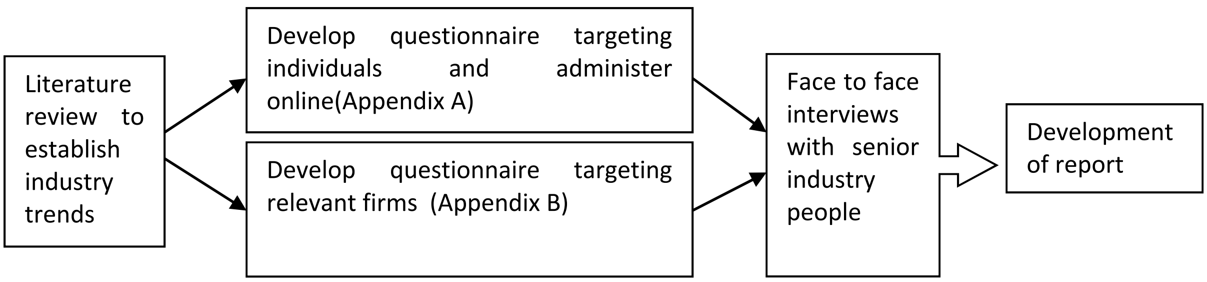
- Trends and impacts on engineering and design in Western Australia.
- An assessment of cost competitiveness of Western Australia in comparison with offshore engineering and design services for resource projects.
- An assessment of the capacity of Western Australia to undertake engineering and design for resource projects.
- An assessment of Western Australia's perceived profile, reputation and track record on a world scale.
- An assessment of the inherent advantages and disadvantages, strengths and weaknesses of sourcing design and engineering services in Western Australia.
- Identify and examine barriers to Western Australia taking advantage of future engineering and design opportunities from major resource project work.
- Possible role of Government to overcome some of the barriers.

Project Methodology

Generally industry participants are the most knowledgeable about their industry. The project methodology has been designed to capitalise on this and therefore focused on engaging industry participants throughout the study.

As a first step, a substantial literature review was undertaken to identify issues and trends facing engineering design in oil and gas projects. Following this literature review, a questionnaire was developed and administered online; targeting engineers working in the industry. Another questionnaire was sent to a number of companies active in the oil and gas industry. Subsequently, a number of key senior stakeholders were interviewed. An overview of the project methodology is shown in the figure below.

Figure 1 - Project Methodology



Online Questionnaire

Following the literature review, a questionnaire was developed and administered online. A copy of the questionnaire is provided in Appendix A. Industry associations have been solicited to encourage their members to complete the questionnaire. In particular, the support of Engineers Australia and the Association of Professional Engineers, Scientist and Managers Australia (APESMA) have been very valuable in securing responses and are hereby acknowledged.

The online questionnaire has been very successful with 553 responses. Some respondents did not complete all the questions and adjusting for these factors 402 questionnaires have been used in the analysis.

The figures below provide background on the 402 respondents. The figures show that the respondents are representative of all major sectors of the industry, including resource developers, EPCM/EPC companies, consultants and other sectors. The respondents are also very well qualified with the majority having a degree or better. They are also very experienced with more than 70% of respondents having more than 10 years industry experience.

Figure 2 – Industry Representation of Online Respondents

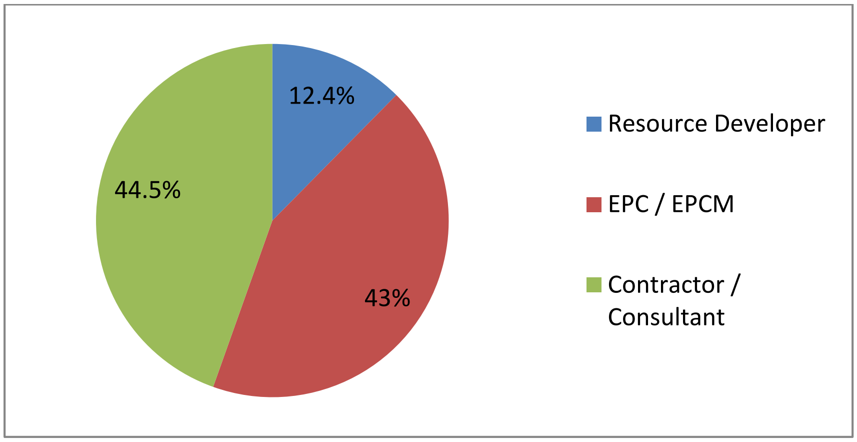


Figure 3 – Qualification Level of Online Respondents

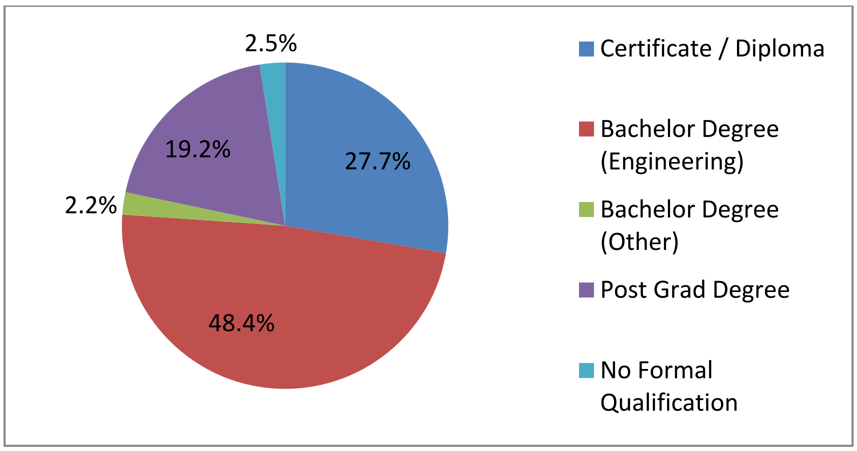
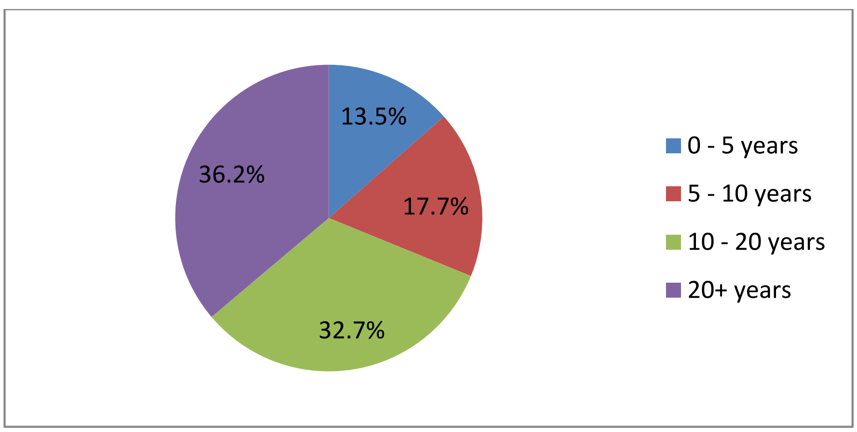


Figure 4 – Years of Industry Experience of Online Respondents

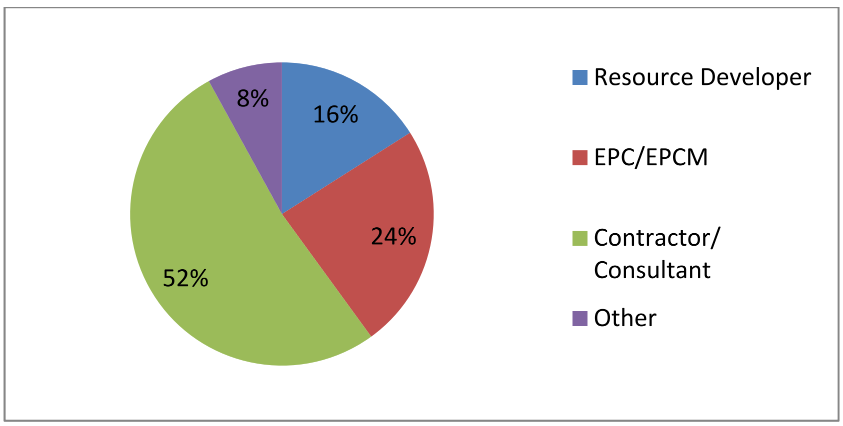


Company Questionnaires

The company questionnaire focused on obtaining more formal views related to availability of skills and intentions about recruitment. This questionnaire was administered by the Department of Commerce. Seventy eight questionnaires were sent to various companies and 25 were returned. A copy of the questionnaire is provided in Appendix B.

The number of questionnaires returned is not sufficient to make general conclusions about the whole industry in WA. However, the industry spread (Figure 5 below) allows some conclusions to be drawn from the data about industry size and numbers of the various types of engineers employed and future recruitment patterns between the various industry groups.

Figure 5 – Industry Representation of Company Questionnaire



Interviews

To explore various issues related to study in more detail, a number of discussions and structured interviews were conducted with senior people in the industry. These included resource owners, EPCM companies and other service providers and contractors. Representatives of the following companies and organisations were interviewed.

Chevron	Worley Parsons
Shell	Genesis
ConocoPhillips	APESMA
Technip	Dare Contracting Services
Clough	Minerva Engineers
JP Kenny	Engineers Australia
Total Dynamics	

Structure of Report

The structure of the report is as follows:

- Section one provides an introduction to the report
- Section two provides a background on Engineering Design
- Section three identifies macro trends impacting on Engineering Design
- Section four discusses WA's capability, capacity and competitiveness
- Section five identifies WA's track record, reputation and profile
- Section six suggests policy considerations
- Section seven draws conclusions

Note that Appendix C provides an analysis of the official employment data available for the oil and gas industry in Western Australia

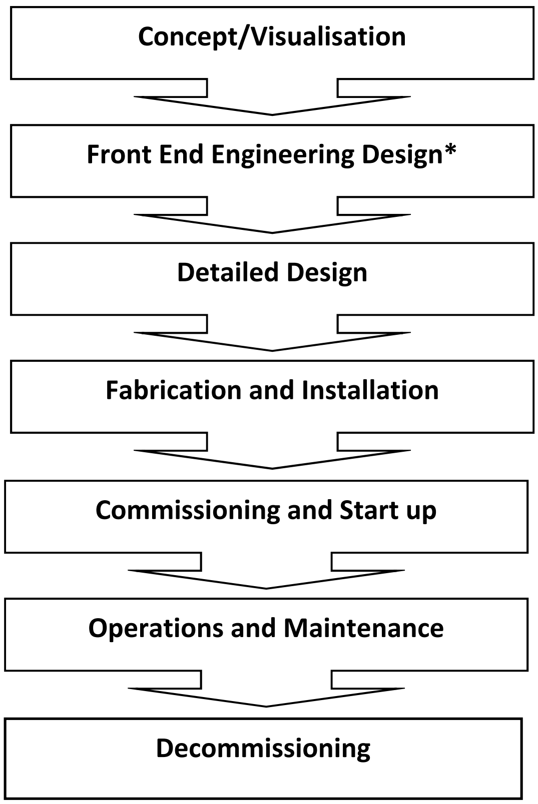
Section 2 – Background on Engineering Design

This section provides some background on engineering design. It is best to understand engineering design within the context of project phases. This is therefore discussed first and is followed by a more detailed discussion of the various elements related to engineering design.

Project Phases

LNG projects (and other large engineering projects) generally follow a number of phases. These phases are sometimes called different names by different proponents but are generally as indicated in the figure below.

Figure 6 - Project Phases



*Final Investment Decision (FID) generally takes place after FEED but in more complex projects this is sometimes delayed until part of the detailed design has been completed.

Table 1 provides a more detailed explanation of various project phases.

Table 1- Detailed Project Phases

OIL & GAS PROJECT PROCUREMENT							
PROJECT INITIATION	PRE-FEASIBILITY	FEASIBILITY STUDY	BANKABLE FEASIBILITY STUDY	FINAL INVESTMENT DECISION (FID)	PROJECT EXECUTION	MODIFICATION MAINTENANCE & OPERATIONS (MMO)	DECOMMISSION
	FRONT END ENGINEERING & DESIGN (FEED)						
• Application for drilling or exploration licences • Seismic work & analysis • Drilling contractors & component suppliers • Geology work • Geophysics work • Mariners & marine support • Logistics support • Initial environmental investigations	• Operator establishes separate project office • Engineering company engaged to design project concept • Environmental studies • Resource estimation from continued drilling & associated activities as listed under Project Initiation • Economic evaluation • Marketing & sales activities • High level capex & opex estimations	• Engineering company refines project concept & seeks preliminary pricing estimates from construction & equipment companies • Environmental proposal commences • Markets & sales identified • High level capex & opex estimations are refined • Govt approvals process initiated • Geotechnical investigation of site commences • Resource definition from continued drilling & associated activities as listed under Project Initiation • Community contact program commences	• Engineering company decides on project process & more defined project drawings are produced • Subcontract engineering companies engaged for specific items (wharf or load out jetty) • Procurement & contracting strategy locked in • Long-lead or critical equipment tenders & construction contracts are issued • Vendors submit firm pricing to Requests for Quotations • Approved vendor list is developed • Environmental document is prepared for submission to Govt • Preliminary letters of intent between buyers & sellers are exchanged • High level capex & opex are defined to +/- 10% • Community contact program continues • Geotechnical investigations of site continues • Early site works tenders are issued	• Contracts signed with engineering companies • Long-lead or critical equipment tenders & construction contracts awarded (dredging, fly camp, water, power & other support facilities) • Environmental approvals issued • Equipment procurement tenders & construction contracts are issued • Drilling of project wells commence • Logistics contracts awarded	• Engineering companies perform tasks • Equipment procurement tenders & construction contracts continue to be issued & awarded • Drilling of project wells continue • Subsea & pipeline activity commences • Construction & other contractors commence work on site • Maintenance contract strategy selected • Operational staff commence training • Commission & testing	• Operator increases technical & non-technical staff to manage operations • Engineering companies engaged on a needs basis or period contract • Offshore & onshore maintenance contracts issued • Maintenance of critical equipment items issued • Marine support contracts issued • Shipping contracts awarded • Operational staff employed	• Engineering company engaged to decommission project • Govt approvals • Environmental activity • Plant demolition companies engaged • Plug wells & remove wellheads & pipelines • Remove or dispose of platform & topsides • Waste management program established • Remove & dispose of waste • Rehabilitation of vegetation & marine areas

Source: WA Dept. State Development

For the purpose of this project the focus is on the first three phases. These are discussed below.

Concept / Visualisation

The concept / visualisation phase starts after a resource has been discovered. Activities in the concept / visualisation phase include identification and scoping where various initial concepts and options are considered, preliminary cost estimates are undertaken and initial risk assessments are completed. The objective of a concept study is to strategically review a number of alternative project schemes to give sufficient information to enable a go or no-go decision on whether to progress the most promising development pathway.

Conceptual studies typically last for three to twelve months, during which many alternatives are considered. Often a cost estimates to ±30–40 per cent are generated, including preliminary costs for major equipment and factored estimates for piping, civil, electrical and instrumentation needs.This phase is also often called Pre-FEED.

Front End Engineering Design (FEED)

FEED follows the initial concept phase. It is undertaken to analyse the various technical options for new development with the objective of more clearly defining the project.

FEED phase includes pre-feasibility (sometimes this is included in concept phase), feasibility and bankable feasibility studies. During FEED a workable process design is generated, project costs are analysed, systems are identified and the initial plot layout is proposed. The design is reviewed for safety and environmental considerations. Detail is added to generate an agreed process design and contractual information.

During FEED an engineering solution is developed with sufficient detail to enable a ±20 per cent cost estimate to be established. Additionally, the project schedule is further developed and often commercial contracts are being prepared. During this phase the project team expands and input is provided from engineering, estimating, planning and legal departments. Depending on the size of the project this phase can take up to 2 years.

In international project-financed projects, the lending institutions are the ones who set the level of accuracy required for cost estimates to evaluate a proposed loan. This drives the detail required in FEED. Inherently, a FEED is not sufficient to specify, purchase, install, startup, or operate a major process. The FEED is an outline with basic engineering done. It is used to help making a final investment decision (FID) and to obtain the funds required to undertake the necessary engineering that will yield the final, detailed design that can subsequently be specified, purchased, fabricated, installed, started up and operated.

FID is generally based on the FEED but in more complex projects this is sometimes delayed until part of the detailed design has been completed.

Detailed Design

Following FEED, detailed design is undertaken. The focus is on designing all project elements to sufficient detail so that these can be fabricated and constructed. The project team takes the FEED design and implements rigorous design calculations, safety and environmental auditing, interdisciplinary review and operability checks. The workload rises as numerous documents and information are transferred between parties. This is the busiest time in the design phase of the project. A large number of people are involved in the detailed design phase. Depending on the project, this can be more than 400 design engineers and draughts people.

Detailed design has over time been substantially commoditized and is nowadays mostly undertaken in major design centres. Due to cost pressures these design centres have been relocated to lower cost countries including India, Malaysia, Thailand and Indonesia.

Section 3 - Macro Trends Impacting on Engineering Design

This section explores some of the trends and generic issues which impact on the ability for WA to develop engineering design expertise.

Increasing Importance of Natural Gas as Energy Source

As the world population increases and more and more people and countries urbanise and industrialise, the demand for energy will increase. The IEA estimates that the world demand will increase by 45 percent from the current levels. This equates to 1.5 per cent increase per annum, which is higher than the expected population growth.

Figure 7- Forecasted Primary Energy Demand

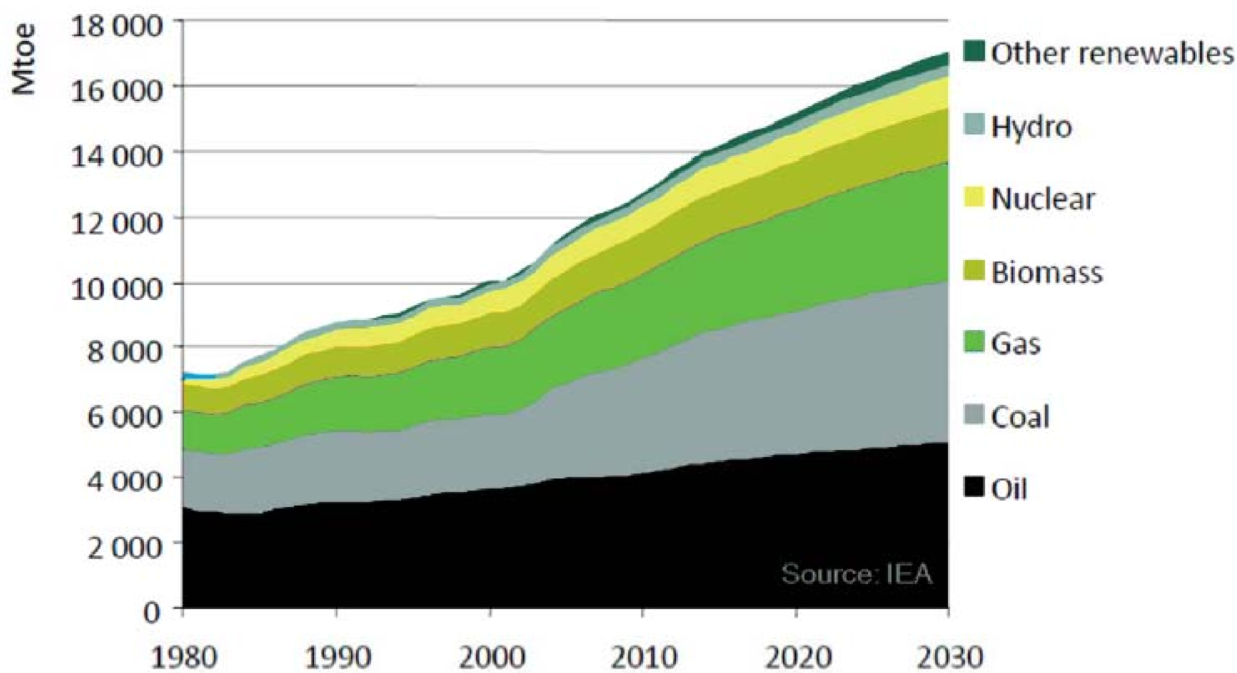
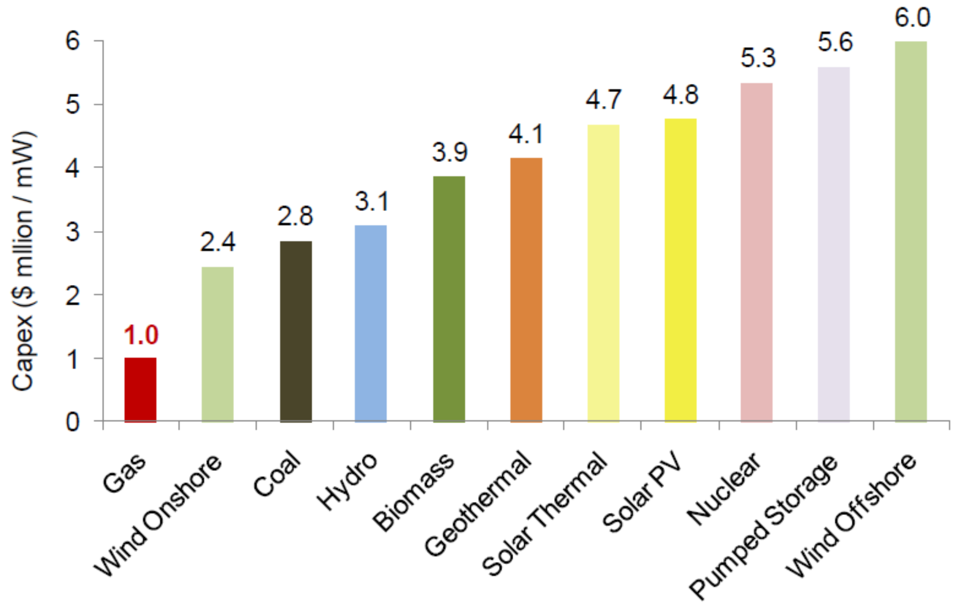


Figure 7 shows that the IEA expects that oil and coal will continue to be important energy sources. However, given natural gas' ability to be a cleaner energy source the demand for gas will continue to rise.

Natural gas presents a competitive advantage over other energy sources. It is seen as an economic source as less capital expenditure is required to generate electricity than almost any other source – see Figure 8. Technological advances are constantly improving efficiencies in extraction, transportation and storage techniques as well as in equipment that uses natural gas.

In addition, it is an environmentally friendly clean fuel, offering important environmental benefits when compared to other fossil fuels. Given the increasing importance of reducing pollution, particularly in the electricity generating sector, it is to be expected that natural gas will become an increasing important source of energy.

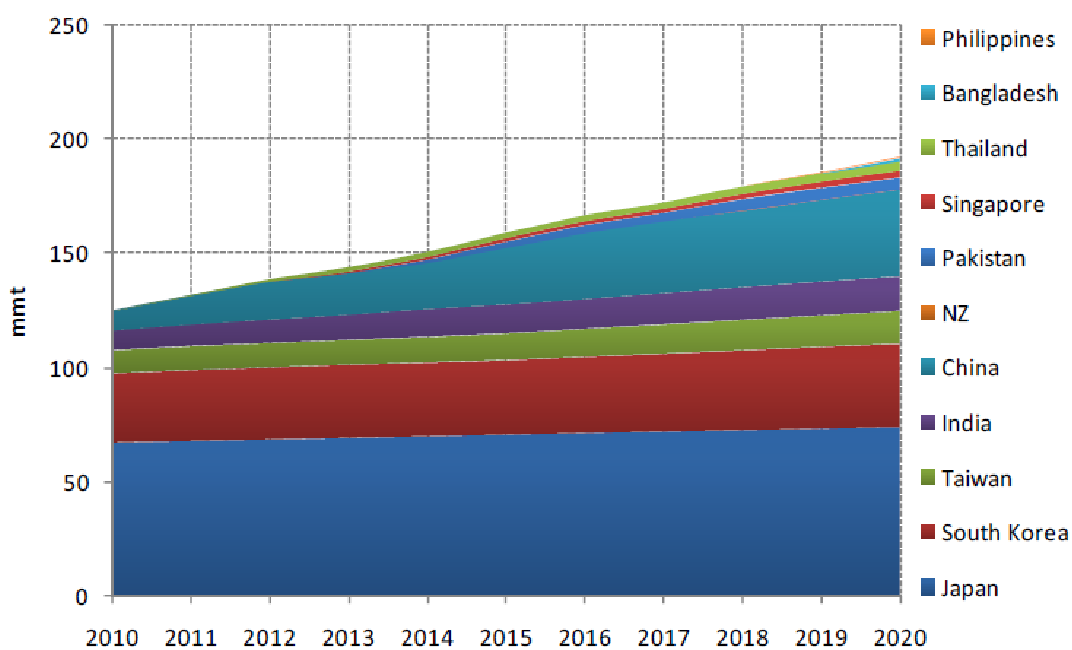
Figure 8- Comparative Capital Expenditure for Energy Sources



Source: Douglas Westwood, 2010

Closer to Australia, the demand for gas in general and in particular LNG, is also expected to increase substantially. Figure 9 shows the project LNG demand in Asia. It is noticeable how considerably the demand for LNG from China is expected to increase.

Figure 9- Asia Projected LNG Demand



Source: FACTS, 2010

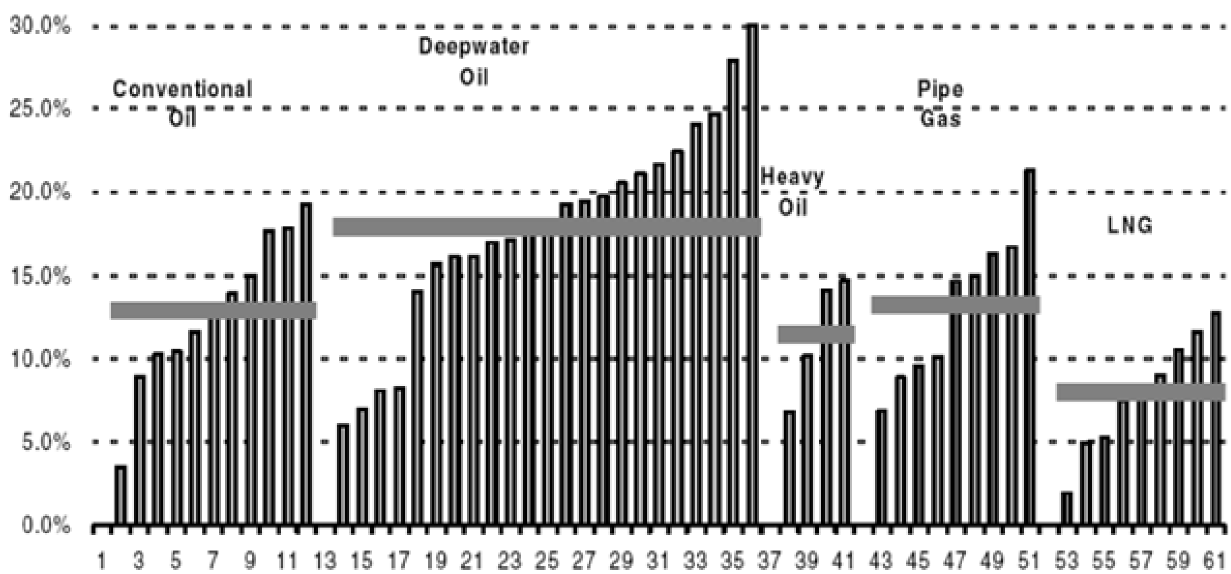
This trend augers well for WA as the demand for LNG resources is expected to remain high and to grow in the foreseeable future. WA has an advantage in its location as a supplier to Asian markets.

Cost Pressures

Costs of LNG projects have increased over the past few years for a number of reasons. These include increased complexity to get to the raw material, limited availability of EPC/ EPCM contractors due to high number of projects worldwide, high material prices including steel, lack of skilled and experienced workforce, exchange rate, etc.

These factors ultimately are all reflected in the financial return associated with projects. As with all investment decisions, various projects need to compete for limited capital. Projects generally get capital allocated if the return generated by the project compares favourably with alternative projects. The costs of LNG projects have increased substantially with corresponding reduction in the internal rate of return (IRR)of these type projects. Figure 10 shows the IRR of a number of projects. It shows the relatively low IRR associated with LNG projects. If this trend continues then fewer LNG projects will achieve FID.

Figure 10 IRR of Various Project Types



Source: Douglas Westwood, 2010

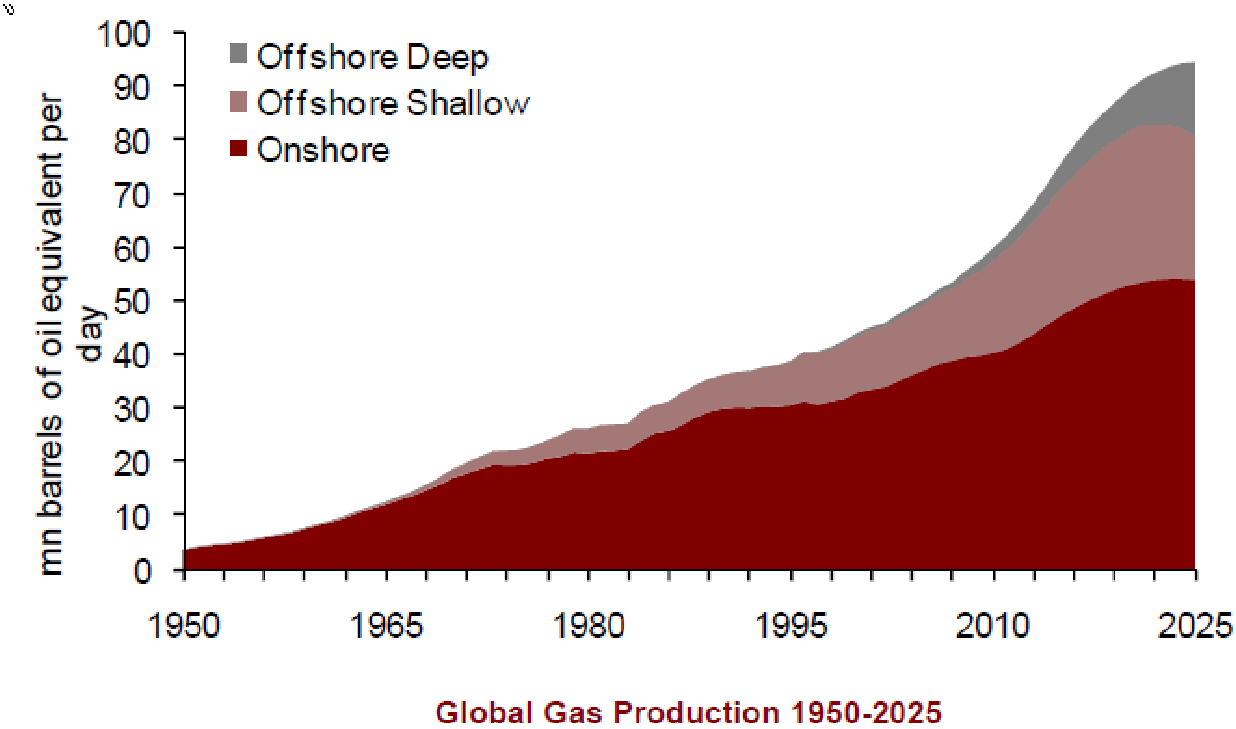
Increased complexity and new technologies

LNG projects are becoming increasingly complex as the need increases to search for new gas sources in more hostile environments. Similarly, cost and other pressures require the development of different technologies which all in turn have an impact on engineering design requirements. Some of these are discussed below.

Increased Complexity

As "easy" sources of gas are becoming increasingly depleted there is a growing need to explore and extract gas from deeper waters. The figure below provides some estimation of the role of deep water gas.

Figure 11 Growing importance of offshore deep water gas extraction.



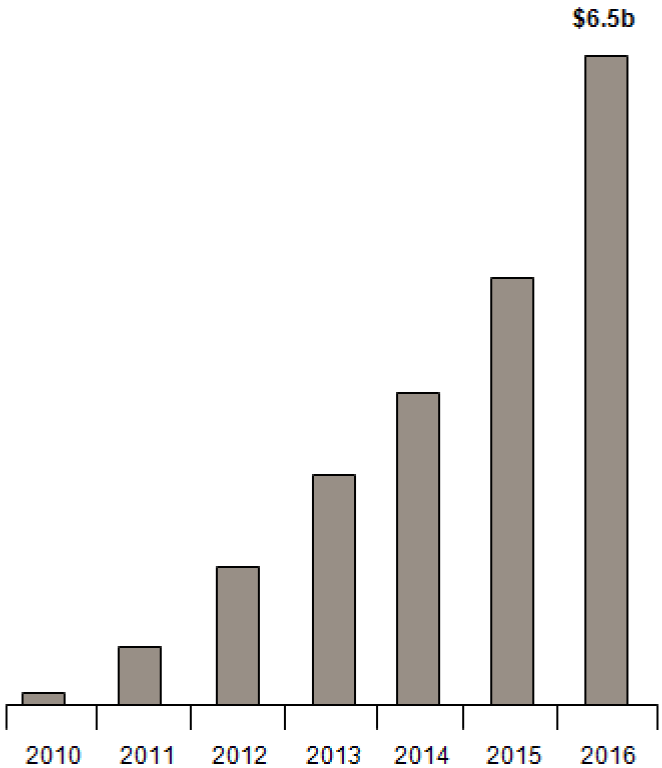
Additionally, due to cost pressures larger and larger LNG trains are being developed. The largest current LNG train is 7.8 Mtpa in Qatar. Larger trains are increasingly complex and require specialist expertise to design and fabricate.

New Technology

There are various technological advances which will change the LNG industry. The most important (in particular for WA) is the Floating LNG facility (FLNG), recently announced by Shell. This technology will enable the development of offshore gas resources that would otherwise remain untapped because the resource is too far from land. Shell awarded the EPCM contract to a consortium of Technip (a French company) and Samsung (Korean) with the construction to be managed in Malaysia, meaning none of the initial phase of development and construction will be undertaken in WA. The trend for using this new type of technology is set to continue with Woodside raising the prospect of FLNG for its Greater Sunrise project in conjunction with the East Timorese and GDF Suez and Santos recently setting up a joint venture to develop a floating LNG project off northwest Australia.

Estimated future FLNG spend is shown in the figure below.

Figure 12 Projected FLNG spend



Source: Douglas Westwood, 2010

The increasing complexity and new technologies have substantial implications for WA. Increasing technologies will require even more specialisation and this will mostly be developed through the large international oil companies (IOC)or EPCM/EPC companies. It is not surprising that FLNG is driven by a large IOC and that the contract was awarded to a major EPCM (Technip) and will fabricated in one of the largest fabrication yards in the world.

Emergence of Engineering, Procurement and Construction Managers (EPCM)

For many years the norm for a resource owner to procure a major construction project, especially project financed projects, has been via fixed price, lump sum turnkey delivery; known as an Engineering, Procurement and Construction (EPC) contract. Increasingly however there has been a move away from using a single contractor for all facets of a project design and construction. This has been mostly due to a move towards risk sharing and increasing move towards cost reimbursable contracts, especially with target price pain/gain mechanism built in. This has led to Engineering, Procurement and Contract Management (EPCM) companies. Under the EPCM model the contractor does no building or construction, rather they manage the design and construction on the owner's behalf. The diagrams below highlight the major differences in management style, demonstrating paths of risk – whilst the EPCM is the main point of contact for the subcontractors; they are only acting on behalf of the owner or resource developer.

Figure 13 EPCM Model

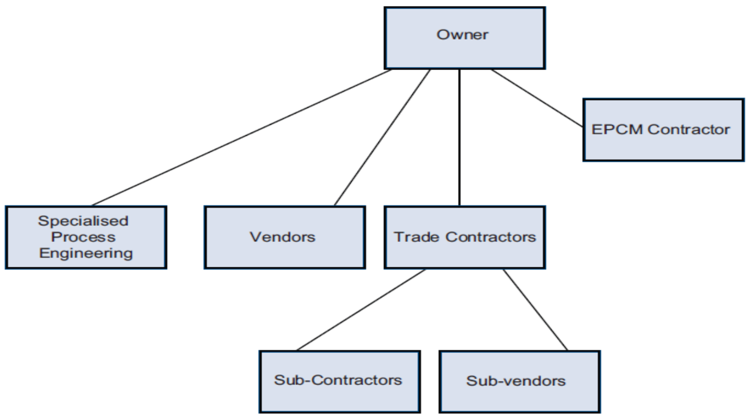
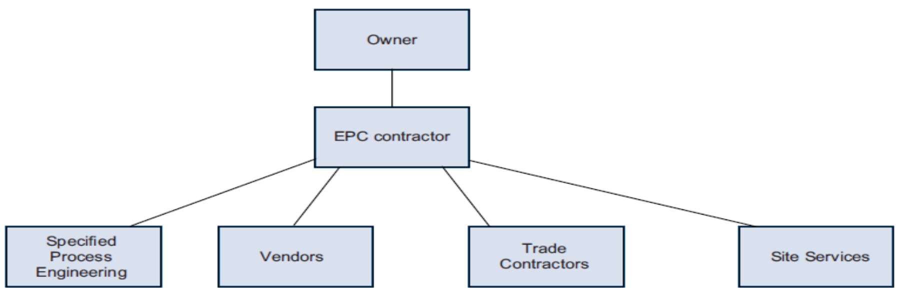


Figure 14 EPC Model



Under the EPCM model, the EPCM contractor will often be responsible for the preparation of the FEED and the complete detailed engineering in accordance with normal industry and good engineering practices. It is normal, therefore, for the EPCM Contractor to have overall responsibility for establishing and maintaining both the design and construction interfaces with vendors and construction contractors. This is done to ensure that their work is performed to the required level and quality, and to a schedule which is compatible with the requirements of the overall project schedule.

The EPCM contractor will usually be responsible for overall co-ordination of the design and construction process although often the EPCM contractor will also appoint a lead contractor amongst the various trade contractors that will take some responsibility for onsite construction co-ordination – even though the EPCM contractor will of course have a heavy site presence with its own construction management team.

EPCM companies are generally very large internationally oriented organisations with various focus areas. For instance some EPCM companies provide all the services required to undertake a project, including initial scoping, feasibility studies, FEED, detailed design, fabrication oversight and installation and commissioning. They often have FEED centres of excellence which require a steady pipeline of projects and also have detailed design centres in low cost environments. Given their global focus EPCM companies often do not have a detailed knowledge of local capability and capacity.

This trend impacts on WA design engineering, as resource developers can use a firm located anywhere globally to manage their design as well as the remainder of the process, with more emphasis being placed on risk avoidance by choosing EPCMs with experience and access to proprietary technology. This trend also impacts WA industry as a whole in that the location of the EPCM contractor often influences

the location of subsequent fabrication. EPCM's often have arrangements with suppliers and/or fabricators of choice who they have alliances or partnerships with and who they use regularly.

Modular Construction

Modularisation refers to the pre-fabrication and pre-assembly of a complete system away from the job site which is then transported to the site. Modularisation can be done in components as site-specific needs dictate. For example; prefabrication, preassemblies or packaged / skidded components all fall under the umbrella of modularisation.

Modularisation is becoming increasingly important as a mechanism for reducing fabrication costs. Given the low IRR on some LNG projects (as discussed previously) some projects will not proceed if fabrications costs cannot be reduced.

There seems to be a closed loop, whereby resource owners are encouraging the use of modularisation to their design companies to save on economic factors and EPCM companies are increasingly encouraging the use of modularisation as part of their construction supply chain in order to more accurately stay with quotes and schedules. This has the double effect of excluding both local engineering as well as local construction expertise in favour of outsourcing. Again, this relies on EPCM engineers providing work to their own supply chains without knowledge of local competencies.

This trend towards modularisation is impacting Western Australia's chances to attract FEED and detailed design opportunities as it is easier for companies to create the designs in the locations in which they will be manufactured. Modules that are prefabricated and shipped as they are required by firms have less need of individual design, and scheduling is easier to control by keeping all processes in one location, such as Malaysia, where some of the major construction yards are located.

Internationalisation of Supply Chains

As with supply chains of other industries, the supply chain in the oil and gas (LNG) sector is increasingly being internationalised. This implies that the various activities in the supply chain that are footloose are undertaken in the part of the world where it makes the most commercial sense to do so. That is, activities are undertaken where it best meets the requirements of available expertise, cost, project schedule, risk management, technology and so forth.

The LNG sector is experiencing this internationalisation of the supply chain in many different ways. Through movement away from stick build to modular fabrication and locating these activities where scale and scope economies can be maximised, overall fabrication and construction costs have been reduced, in some instances by more than 25 percent. Other benefits include schedule compression and improved quality control.

The internationalisation of the supply chains is increasingly impacting on design services. Detailed design is increasingly commoditised and moved to appropriately skilled and low cost centres with sufficient resources. These include India, Thailand, China and South Korea. Similarly, initial and front end design is undertaken by EPCM companies where it is most appropriate for them. This is to some extend driven by costs but also by the availability of highly skilled staff and the need to have a project design pipeline to ensure continued engagement of their staff. This includes centres such as Houston, Reading and Yokohama.

For WA to become a major player in the engineering design area it will not only have to be internationally competitive in terms of price, quality and expertise but also will have to ensure a sufficiently robust pipeline of design opportunities.

Section 4 - WA Capability, Capacity and Competitiveness

This section focuses on assessing WA's LNG design capability, capacity and competitiveness. The focus is on an internal assessment whilst an international comparison is undertaken in the next section of the report.

The capability, capacity and competitiveness have been assessed in a number of ways. In the first instance a list of generic factors influencing capability and competitiveness has been drafted and included in the online survey. This list is provided below.

The assessment has then been refined by assessing competitiveness and capability based on various project phases. Additional assessment has been undertaken based on specific engineering expertise. The results are shown below.

To obtain a more detailed understanding of the view related to engineering design capabilities, responses to the online survey have been categorised based on employment and divided into resource developers (RD), EPCM/EPC companies (EPCM) and consultants who provide services to both resource developers and EPCM companies (Consultants). This provides the opportunity to undertake a comparative analysis.

Overall Assessment

As a starting point for assessment of WA's capability, capacity and competitiveness a range of factors have been identified through literature reviews and discussions with industry experts. Respondents to the online questionnaire were asked to rate WA against these factors on the scale of: Very Low, Low, Medium, High and Very High.

The factors are:

- Cost competitiveness
- Ability to comply with all technical project specifications
- Quality of final design
- Availability of sufficient engineers and support staff
- Being able to deliver within specified time frames
- Appropriate project management skills
- Capacity to undertake the required work
- Access to propriety technology
- Ability to deliver on budget

The results are shown in the figures below. The first figure shows the results for all the respondents combined while the subsequent figures show the results for the resource developers, EPCM companies and consultants.

The figures show that there is general consensus that WA does well in terms of quality of design and compliance with technical specifications. However, there is also consensus that WA is not cost competitive and that there are not sufficient numbers of appropriately qualified people. In addition, the resource developers are of the view that WA struggles to deliver on time and on budget. The EPCM companies and consultants, however, are of a view that WA can deliver on time and on budget. All respondents agree that there is sufficient capacity to undertake the work.

Figure 15- Assessment of WA Competitiveness

All Respondents

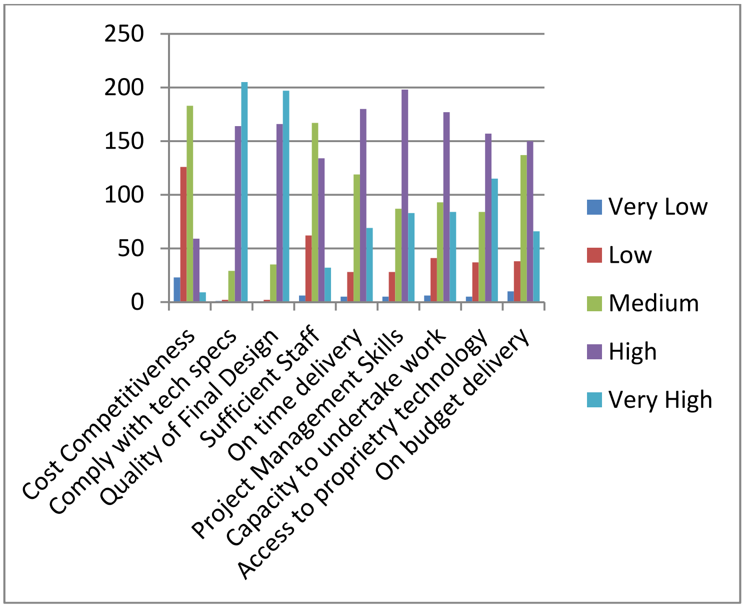


Figure 17- Assessment of WA Competitiveness

EPCM

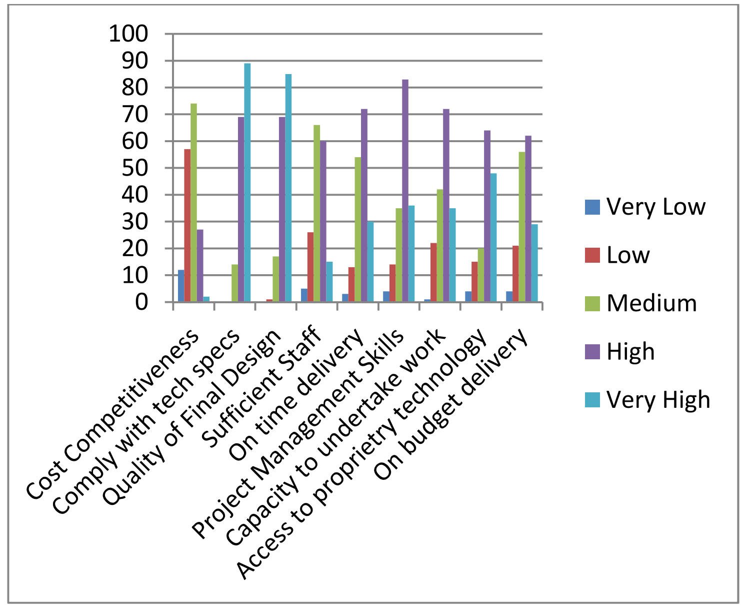


Figure 16- Assessment of WA Competitiveness

Resource Developers

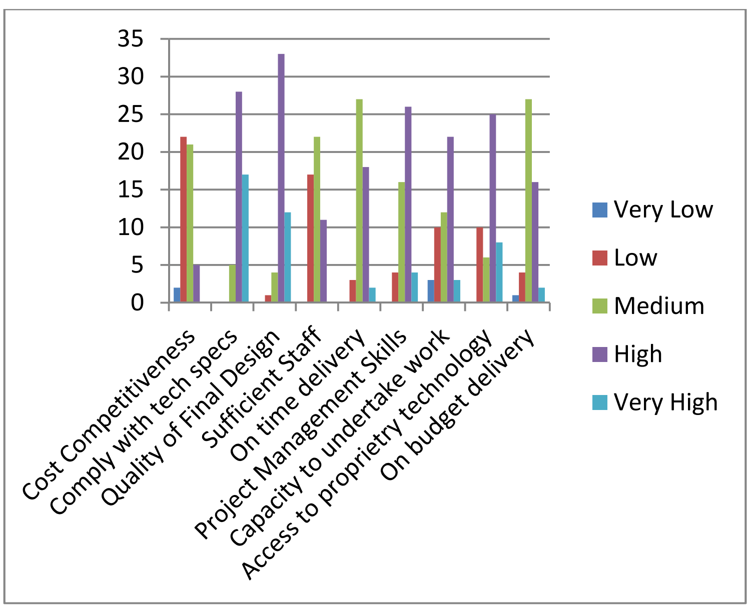
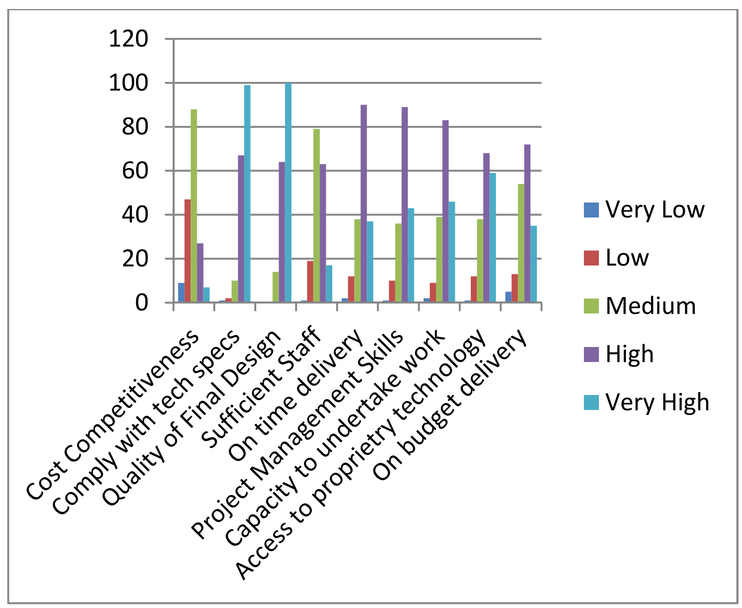


Figure 18 - Assessment of WA Competitiveness

Consultants



Capability Related to Key Project Phases

An assessment of WA's capability has been undertaken focusing on the key project phases. This provides an overall perspective of the capacity and capabilities. Respondents were asked to rate WA's capability to undertake the following:

- Initial scoping
- Feasibility assessment
- FEED
- Detailed design
- Project procurement
- Project construction management
- Comprehensive EPC/ EPCM services
- Risk assessment

The results from the online survey are shown in the figures below.

The overall figure shows that the general view from the respondents are that WA has high to very high capabilities in most phases of a large gas project. The scores are the highest in initial scoping, feasibility studies and FEED. In none of the phases is there a view that WA has overwhelming low or very low capability. Two areas have somewhat lower scores and these are detailed design and comprehensive EPCM services.

The figures show that respondents employed by resource developers have a somewhat different view compared with EPCM and consultants. The resource developers are of a view that WA has somewhat lower capability in EPCM, detailed design and medium to high capability in construction management. In contrast EPCM and consultants are of a view that WA has high to very high capabilities in all the areas.

Figure 19 Assessment of WA Capability Related to Key Project Phases

All Respondents

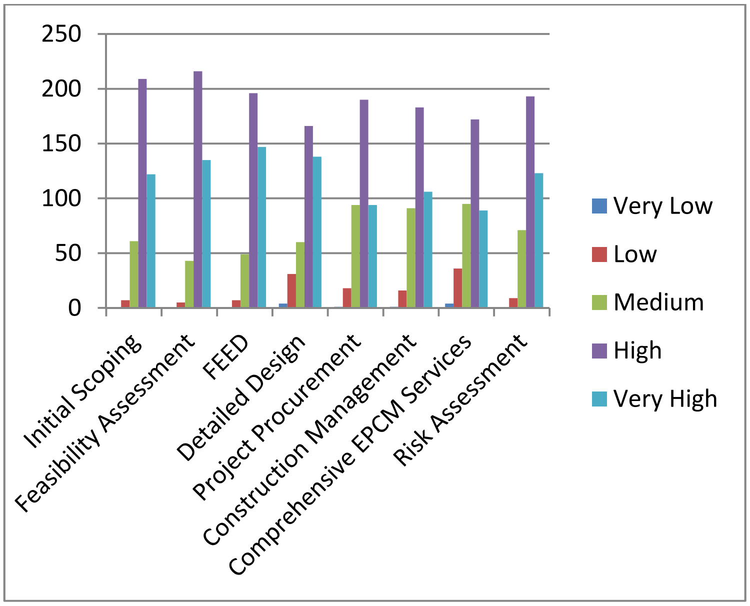


Figure 20 Assessment of WA Capability Related to Key Project Phases

Resource Developers

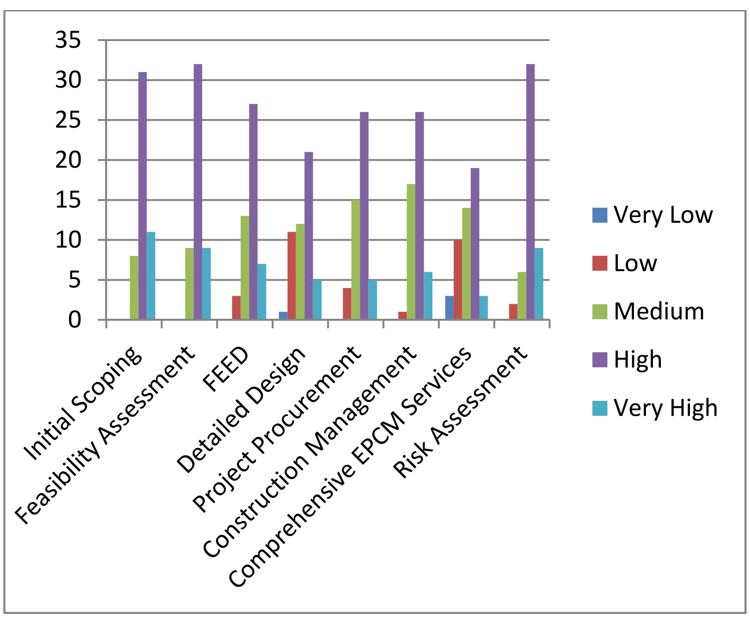


Figure 21 Assessment of WA Capability Related to Key Project Phases

EPCM

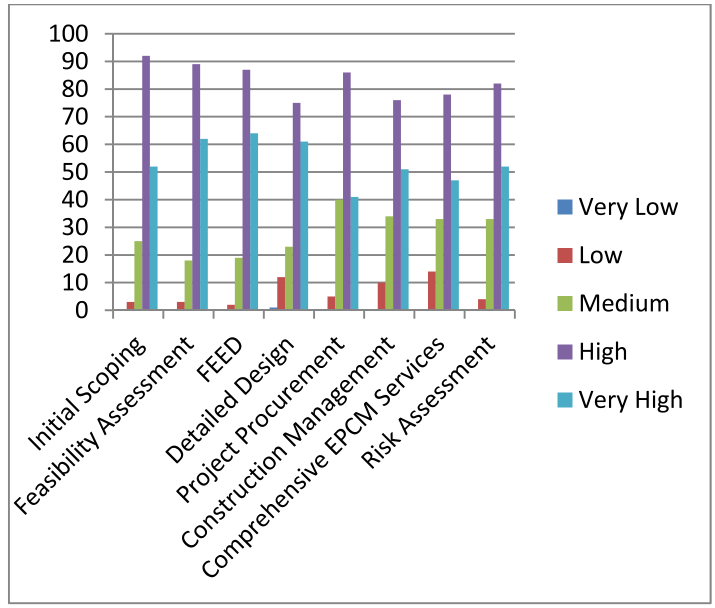
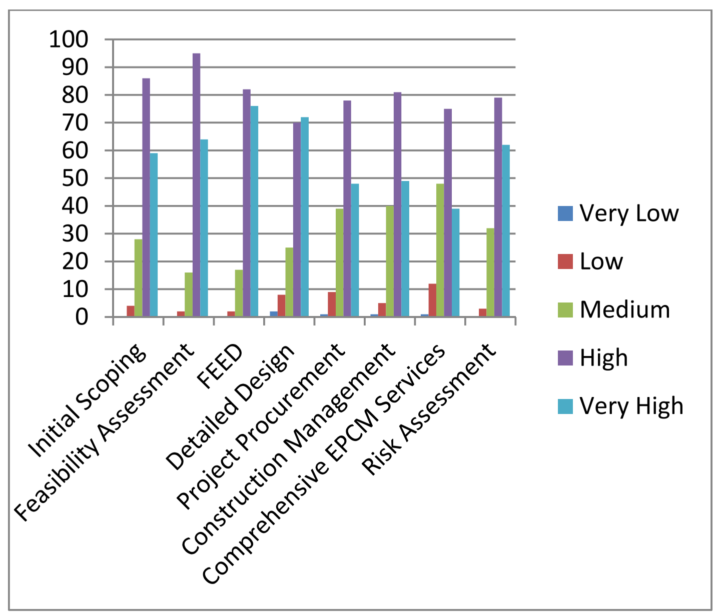


Figure 22 Assessment of WA Capability Related to Key Project Phases

Consultants



Discipline Capability

There are a number of engineering disciplines which are important to undertaking engineering design and execution of large scale oil and gas projects. The required expertise is wide ranging and varied. WA's capability has been assessed focusing on the following discipline capabilities:

- Process /chemical engineering
- Mechanical / piping engineering
- Electronic / instrument engineering
- Electrical / power engineering
- IT / telecommunications
- Civil and infrastructure engineering
- Structural engineering – onshore
- Structural engineering – offshore
- Subsea engineering
- Project management

The results are shown in the following figures.

The figures show that resource developers, EPCM and consultants combined are of the opinion that WA has substantial expertise in all the key areas of an oil and gas project. There are some discrepancies between the view of the resource developers and the EPCM and consultants. The resource developers have a view that WA has good to reasonable expertise while the EPCM contractors and consultants view the expertise to be good to excellent. The area of subsea engineering has the highest concern but is never the less viewed as reasonable level of expertise.

Figure 23- WA Discipline Capability

All respondents

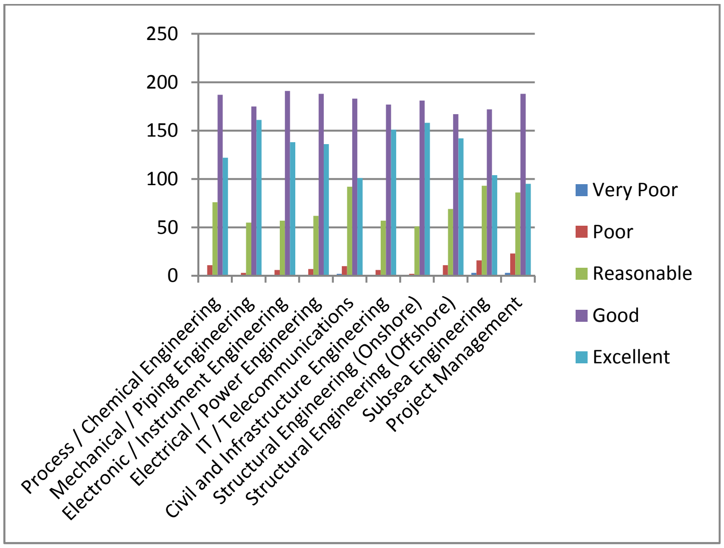


Figure 25- WA Discipline Capability

EPCM

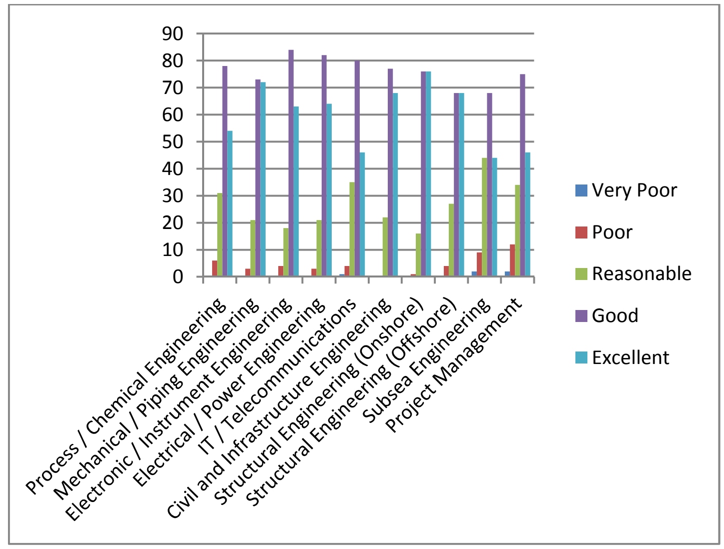


Figure 24- WA Discipline Capability

Resource Developers

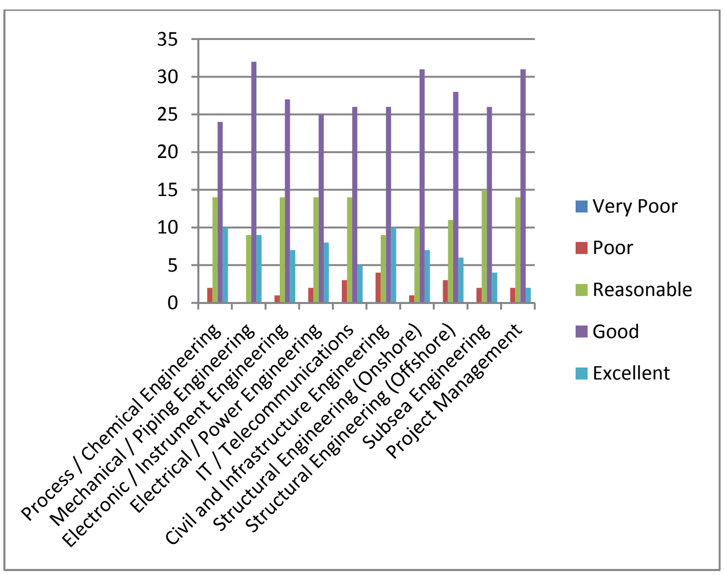
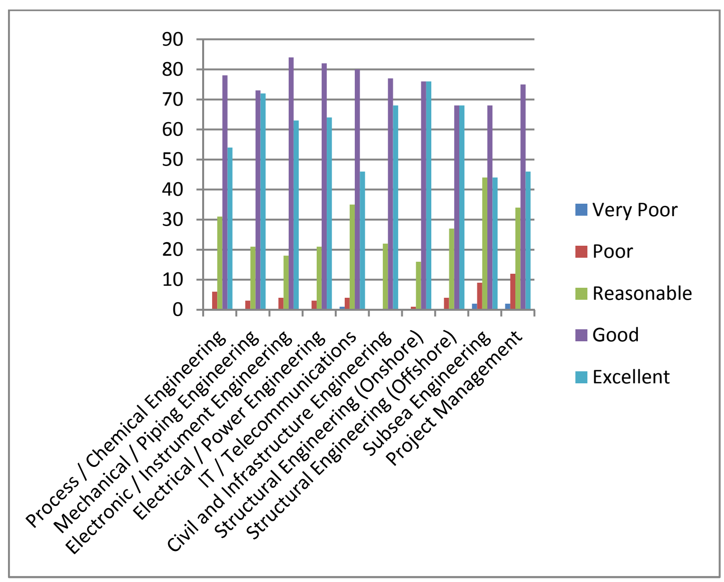


Figure 26- WA Discipline Capability

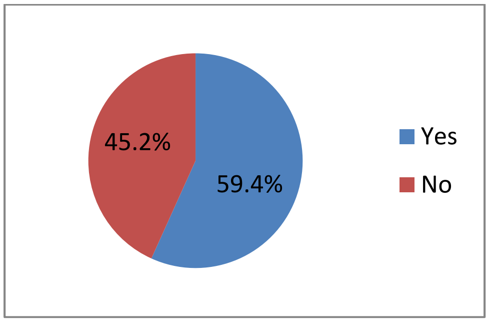
Consultants



Training and Education Facilities

Training and education facilities are important as they are important in developing capability and capacity and subsequent competitiveness of a sector. This has been explored in the online survey by asking the question: *"Are there sufficient education and training opportunities to develop engineering design expertise in your firm or in WA?"*

Figure 27 Assessment of Adequacy of Education and Training Facilities in WA



Although the majority of respondents indicated that there are sufficient education and training opportunities, 45.2 percent of respondents indicated that the opportunities are not sufficient. This is of some concern.

Competitiveness Influenced by Government Activities

Competitiveness is impacted by various Government driven laws, policies and initiatives. How these impact on engineering design have also been explored in the online survey. Respondents were asked to rate the impact of the following factors on design competitiveness:

- Legal and regulatory environment
- Tax levels and laws
- Occupational health and safety (OHS) laws and regulation
- World Trade Organisation (WTO) conventions
- Bilateral trade agreements
- Government industrial development policies
- Labour laws and regulations
- Federal / State Government relations
- Australian sovereign risk profile

The results are shown below.

The figures show that none of the issues listed are seen as a strong barrier to facilitating engineering design in WA. Conversely, none of these policies are seen to be strongly supporting design competitiveness. Some of the factors are seen as weak barriers and these include tax levels and laws, labour laws and regulations and Federal/State Government relations. The resource developers are of the opinion that government industrial development policies and labour laws and regulations are some barriers to the development of engineering design. To a lesser extent tax laws and levels and Federal/State Government relations are seen as some barriers.

Figure 28- Impact of Government on Competitiveness

All Respondents

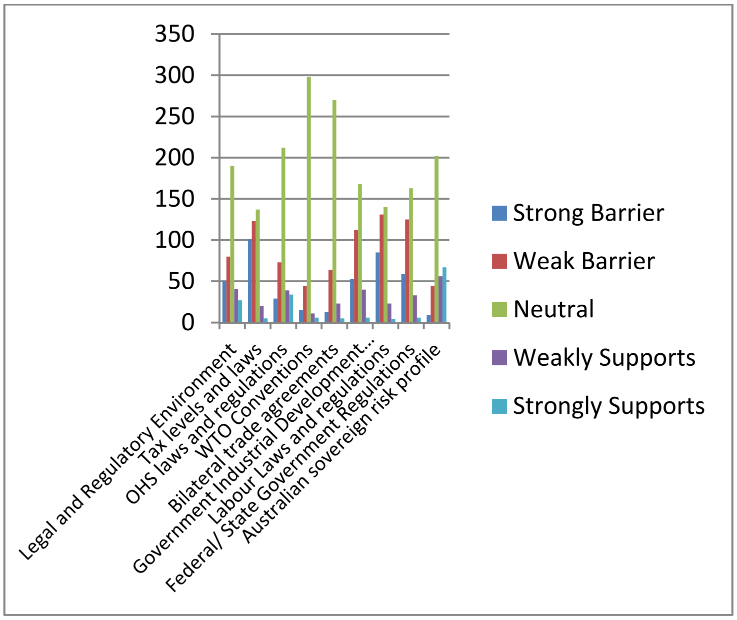


Figure 30- Impact of Government on Competitiveness

EPCM

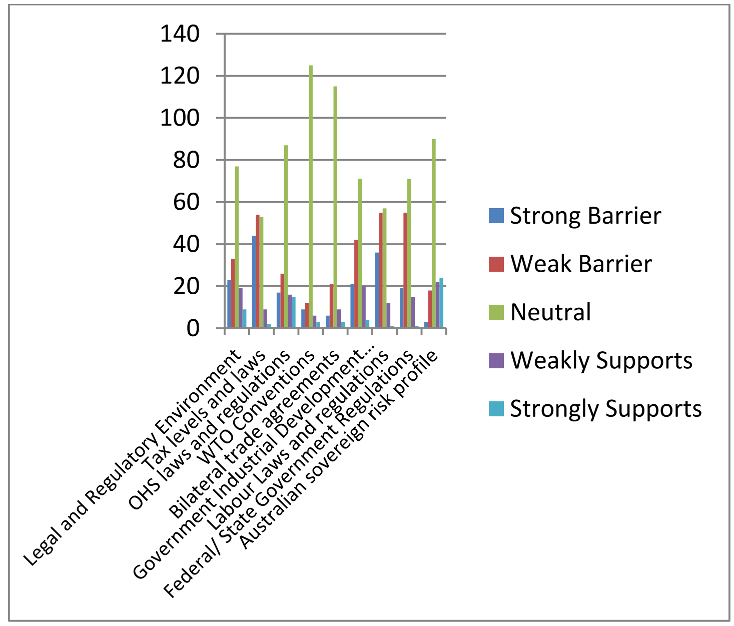


Figure 29- Impact of Government on Competitiveness

Resource Developers

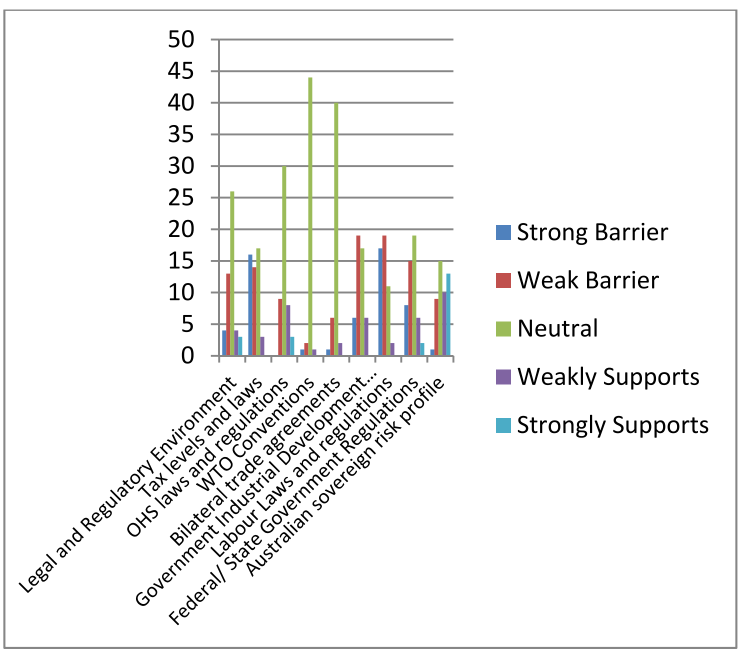
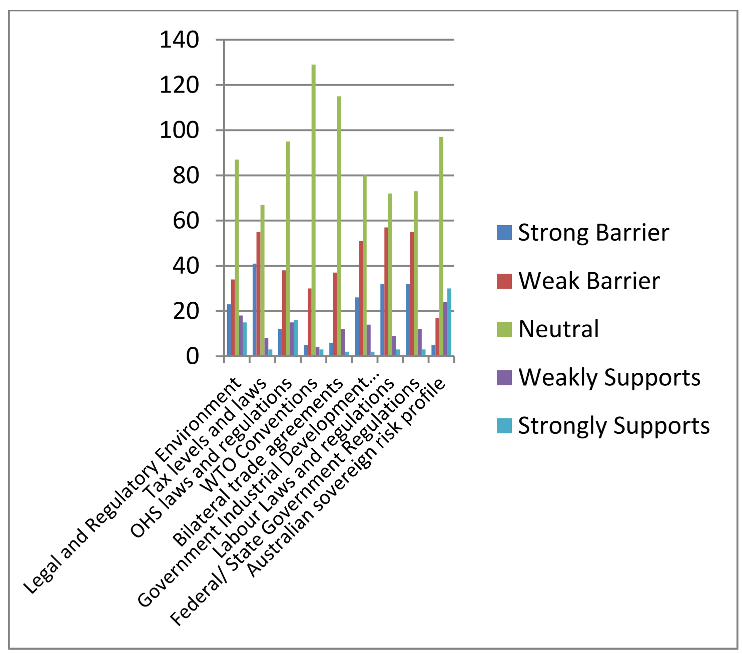


Figure 31- Impact of Government on Competitiveness

Consultants

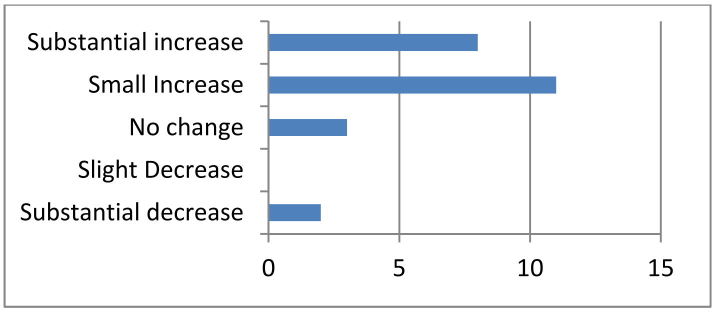


Capacity

The design capacity in the industry has been explored in a number of ways. In the first instance, an analysis was undertaken of officially available data. Although some data are available related to the oil and gas industry in WA, none provide substantial insight into the design capability. Given the marginal relevance, the analysis is provided in Appendix C.

The capacity in the industry has been further explored through the company questionnaires. Companies were asked about their intention regarding recruitment of engineers in the oil and gas sector. The results are shown below. It shows that most companies are planning to have a small or substantial increase in engineering capability.

Figure 32 –Company intentions to employ additional engineering professionals in the next 12 months



Additionally the companies were asked about their experience in recruiting suitably qualified engineers. The results are presented below, showing that most companies experience some difficulties while some experience severe shortages in some areas.

Figure 33 – Perceived availability of engineering professionals

Section 5 - WA Track Record, Reputation and Profile

This section reviews WA's track record, reputation and profile. The focus of the section is to provide an external / international perspective on WA's profile and reputation. This contrasts with the previous sections where the focus has been on a more internal assessment.

Track Record

WA has a varied experience related to natural gas related projects and in particular engineering design. WA has been successful in design (and construction) of some offshore oil & gas work in the past decade. These include various Apache wellhead platforms and jackets, and monopods; Coogee/PTTEP Montarra platform and jacket, Bayu Undan platform (Timor Sea), ROC Oil Cliffhead development (onshore and offshore parts), North Rankin 2 topsides, Angel Platform, Pluto platform etc.

In terms of LNG, WA has long had experience in plant design. Some of this expertise was used outside of Australia, for example in Yokohama in the design of Woodside's LNG trains 1 and 2. The biggest success WA has had in LNG engineering design was train 4 when all the engineering design was undertaken in Perth. The train four design project employed 350 people in Perth. After moving design of train 5 offshore, WA has had very limited success.

An overview of WA LNG design experience with the various projects is provided in the figure below.

Table02- WA LNG Design Experience

LNG Projects	Period	Operator	Eng. Company that DETAIL DESIGN was awarded too	Main design office location	Comments
LNG Trains 1 & 2	1990's	Woodside	Kellogg, JGC & Raymond joint venture (KJR).	Yokohama	Very large onshore Project now completed
LNG Train 3	1990's	Woodside	Kellogg, JGC & Kaiser joint venture (KJK).	Perth	Large onshore Project now completed
Dom Gas	1990's	Woodside	Shell	Holland	Onshore Project now completed
LPG Project	Early 2000	Woodside	Kaiser & Kellogg	Perth	Onshore Project now completed
LNG Train 4	Early 2000	Woodside	Hatch, Clough, KBR & JGC	Perth	Large onshore Project now completed
LNG Train 5	2004	Woodside	Foster Wheeler (F.W.) & Worley Parsons (W.P.) known as (PJV)	London	Large onshore Project now complete
Pluto LNG Train 1	2006	Woodside	F.W. & W.P. (PJV)	London	Very large Project almost completed

Pluto LNG Train 2 & 3 (FEED ONLY)	2008	Woodside	F.W. & W.P. (PJV) and K.B.R.	London (no work in Perth)	Large onshore Project, detail design award later.
Gorgon LNG (Barrow Island)	2008	Chevron & Texaco	Kellogg Brown & Root (KBR)	Approx design split:- London = 60%, Jakarta = 10% Singapore = 20% Perth = 5%	Very large onshore & offshore Project.
Wheatstone offshore platform. (FEED ONLY)	2009	Chevron	Technip	Perth(but work sent to KL)	Offshore Project. The detail design is to be awarded later.
Wheatstone LNG Trains (FEED ONLY)		Chevron	Bechtel	Houston	Very large onshore Project. The detail design is to be awarded later.
Ichthys Field including LNG Trains	2008	Inpex	JGC/KBR	Yokohama	Very large Project
LNG Projects	Period	Operator	Eng. Company that DETAIL DESIGN was awarded too	Main design office location	Comments
PNG LNG facilities (FEED ONLY)	2009	Exxon Mobil	Chiyoda & JGC	Japan	Very large Project multiple sites
PNG LNG (Hides facility) FEED ONLY	2010	Exxon Mobil	CBI/ Clough	Perth	Small facility on one site
Macedon Gas Field Project (FEED ONLY)	2010	BHP Billiton	Worley Parsons	Houston	Offshore Project
Browse Onshore FEED Offshore FEED	2010	Woodside	Bechtel Flour McDermotts JV	Houston Houston	Massive onshore & offshore project
Prelude FEED	2011	Shell	Technip& Samsung	Paris	Large Floating LNG Plant

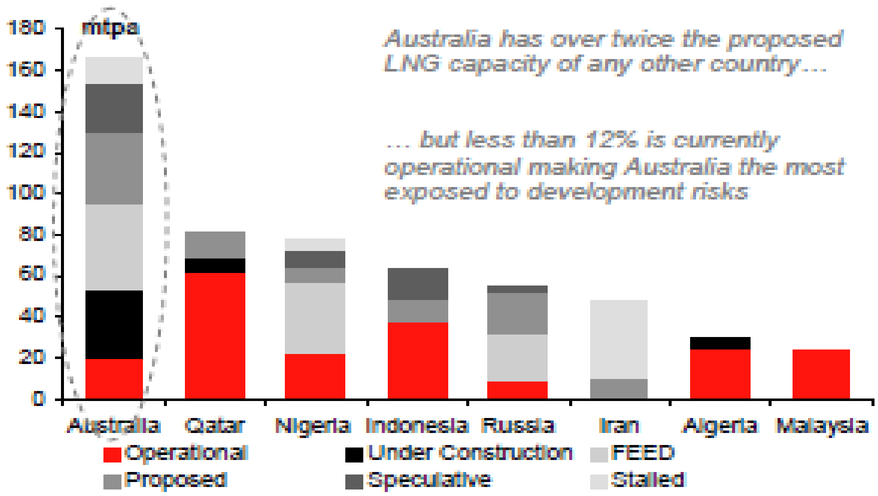
Source: APESMA, 2011

WA Reputation and Profile

The success of WA engineering and design is substantially predicated on the Australian experience and environment. Internationally, WA is not seen as different to the rest of Australia. A recent article by Macquarie Research provides some insights about the Australia / WA reputation and is partially replicated below.

Analysis of existing and proposed LNG capacity shows that Australia has over twice the proposed LNG capacity of any other country – but less than 12% is currently operational, making Australia very exposed to development risk. Conversely, Australia has the largest pipeline of FEED.

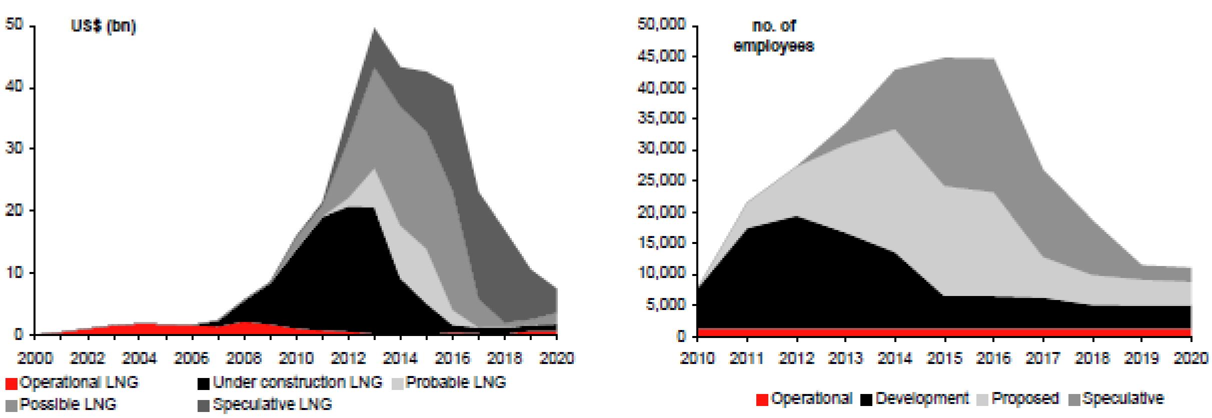
Figure 34- International Comparison of LNG Capacity



Source Macquarie Research, 2010

If all potential LNG projects go ahead, substantial capital and human resources will be required. It is estimated that at the peak almost 50,000 people will be required in the LNG sector alone.

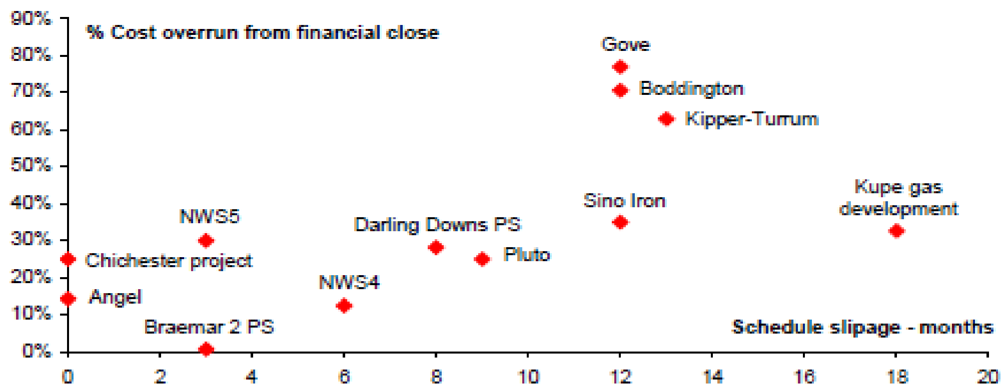
Figure 35- Forecast LNG Capex and Employment requirements



Source Macquarie Research, 2010

Australia has a relatively poor track record in project delivery. It has been estimated that recent mega projects have been typically eight months late and 32% over budget. Some evidence is provided in the figure below.

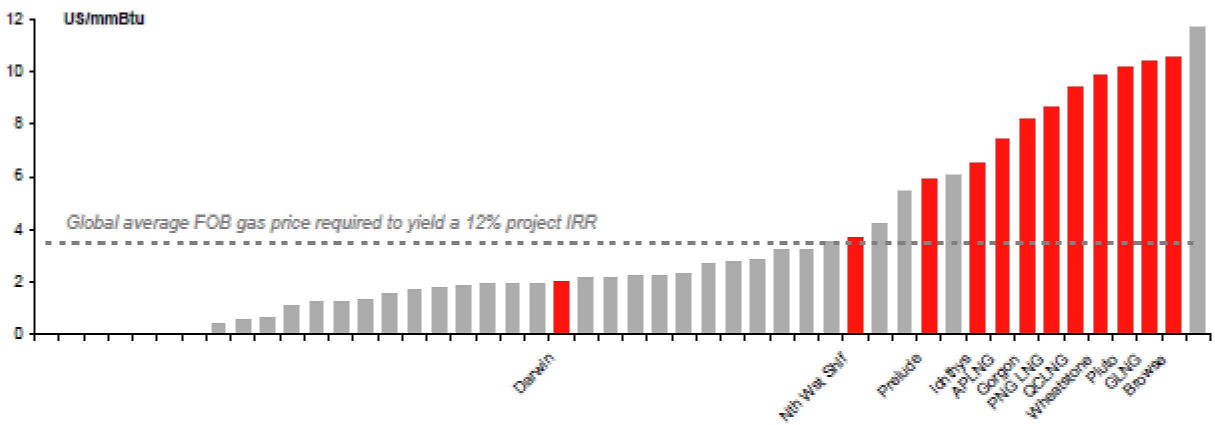
Figure 36- Australia Delivery Experience with Major Projects



Source: Macquarie Research, 2010

Australia sits at the high end of LNG cost curve. This makes a number of projects less certain.

Figure 37- Indicative FOB gas price to obtain 12 % project IRR



Source Macquarie Research, 2010

The above analysis shows that WA/Australia's profile in terms of project delivery is not very complimentary. This impacts on the perception of WA's design capability. It was not possible to undertake an international comparison based on experienced LNG design engineers located outside WA/Australia. However, the issues of reputation and profile were further explored through the online survey.

Assessment of WA's International Profile

In a further assessment of the WA's profile, questions were asked about how WA compares with the world's best. This provides an international context of WA's capabilities and capacities. Respondents were asked to compare WA with the world's best based on the following items:

- Overall technical and engineering expertise
- Size of engineering workforce
- Skill level of engineering workforce
- Productivity of engineering workforce
- Overall capability to undertake engineering and design activities
- Cost competitiveness
- Quality of design product
- Support services (e.g. IT)
- Capability to undertake FEED
- Capacity to undertake FEED
- Capability to undertake detailed design
- Capacity to undertake detailed design

The figures below show the results from the online survey.

The figures above show that respondents believe that WA is equal or better than world's best in terms of technical engineering expertise, skill levels, productivity, quality of design product and overall capability. WA is considered less competitive in size of workforce and cost competitiveness. There are also differences in the responses between resource developers and EPCM and consultants in terms of detailed design. The resource developers are of the opinion that WA is worse than the world's best while EPCM and consultants don't hold the same view.

Figure 38- International Comparison of WA's Overall Technical and Engineering Expertise

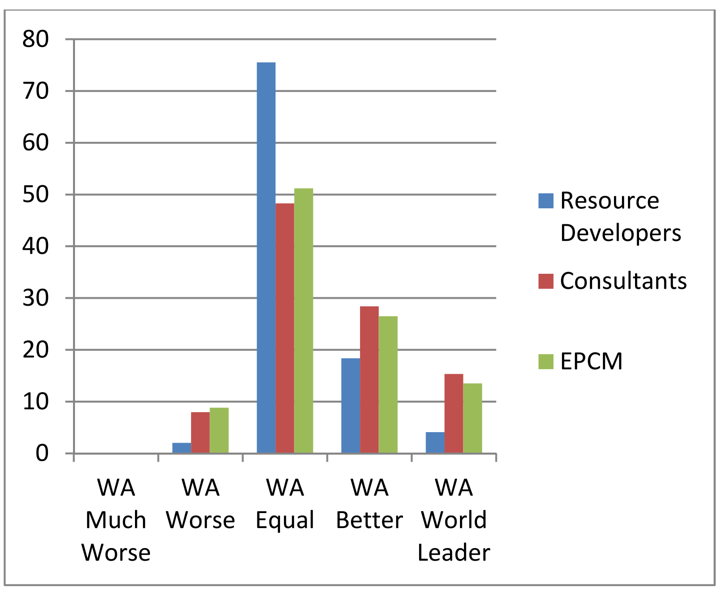


Figure 39- International Comparison of the Size of WA's Engineering Workforce

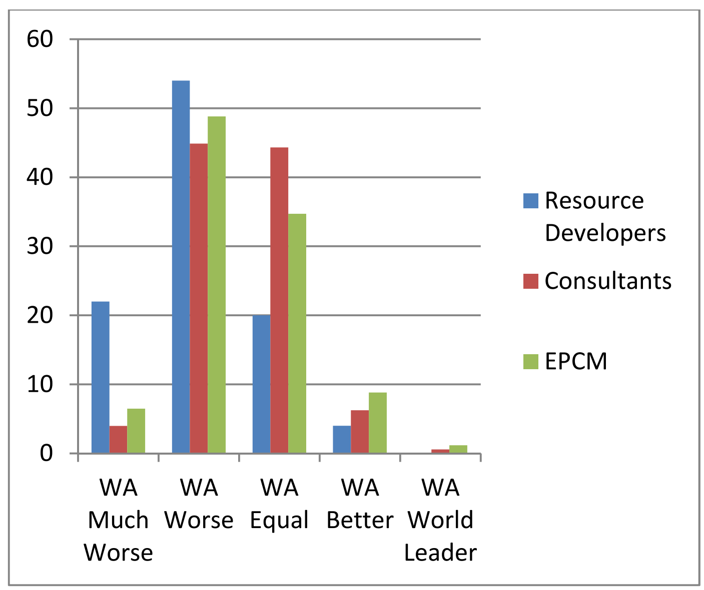


Figure 40- International Comparison of Skill Level of WA's Engineering Workforce

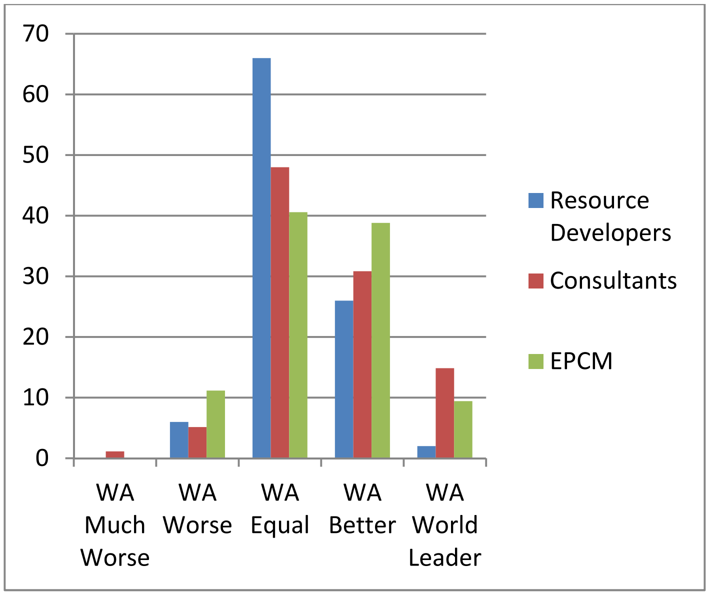


Figure 41- International Comparison of Productivity of WA's Engineering Workforce

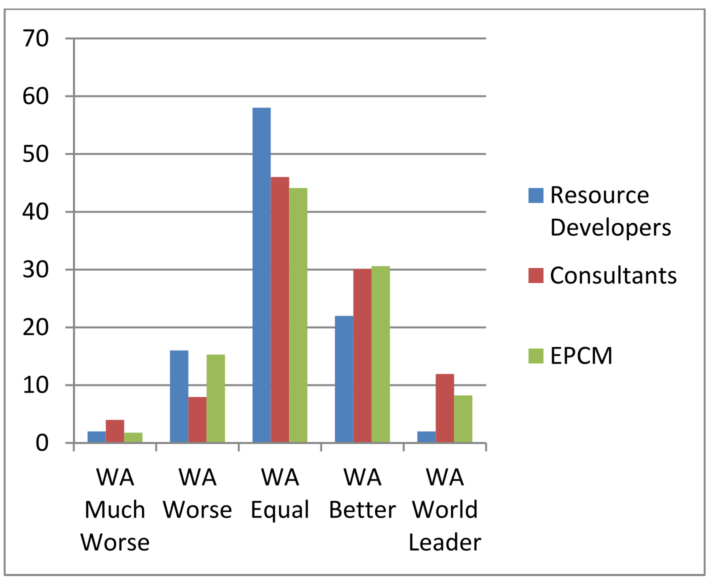


Figure 42- International Comparison of WA's Overall Capability to Undertake Engineering and Design Activities

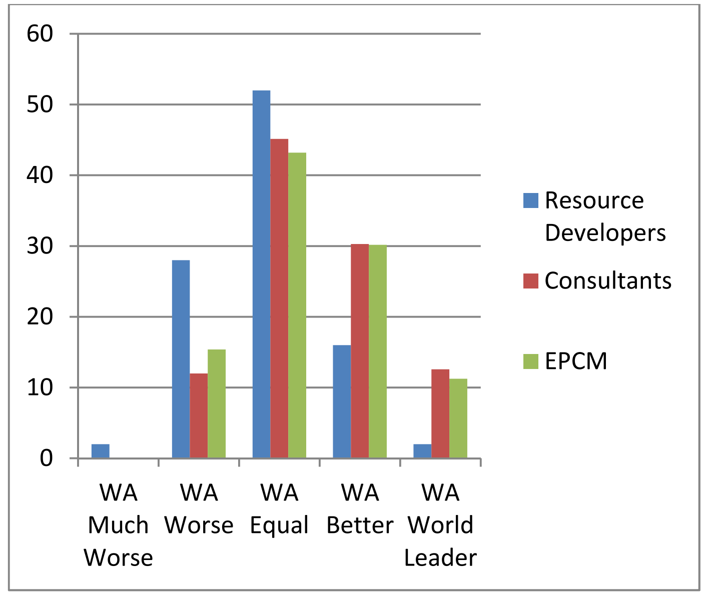


Figure 43- International Comparison of WA's Cost Competitiveness

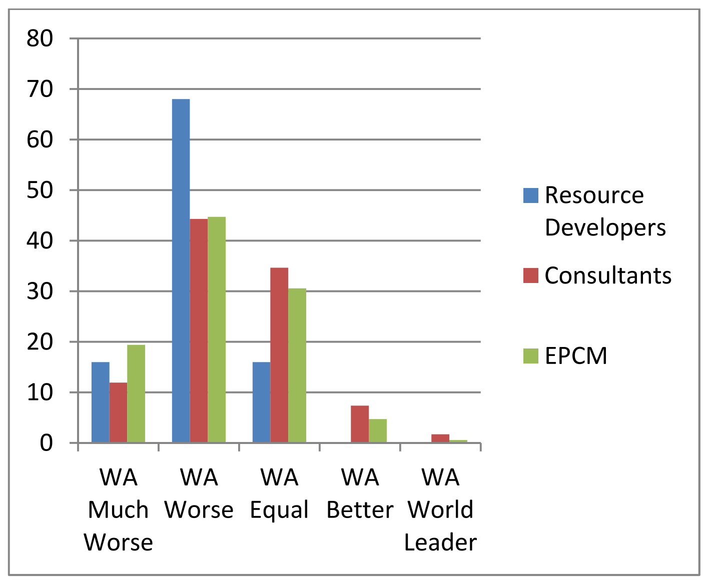


Figure 44- International Comparison of the Quality of WA's Design Product

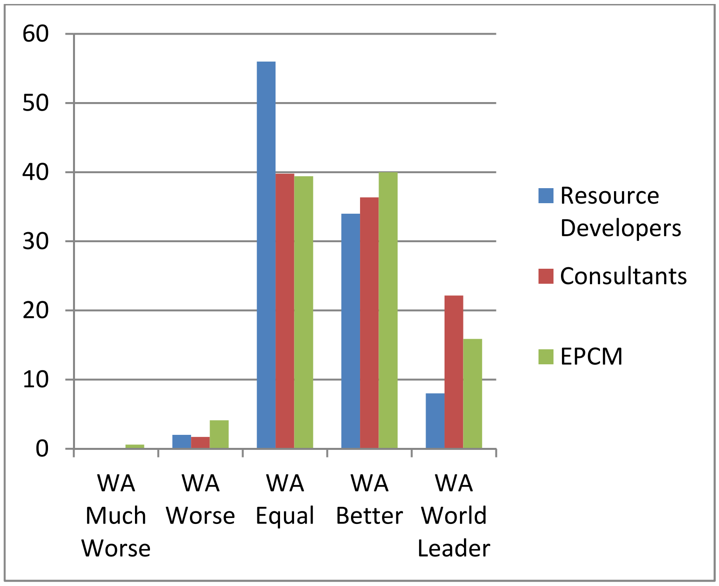


Figure 45- International Comparison of Quality of WA's Support Services (e.g. IT)

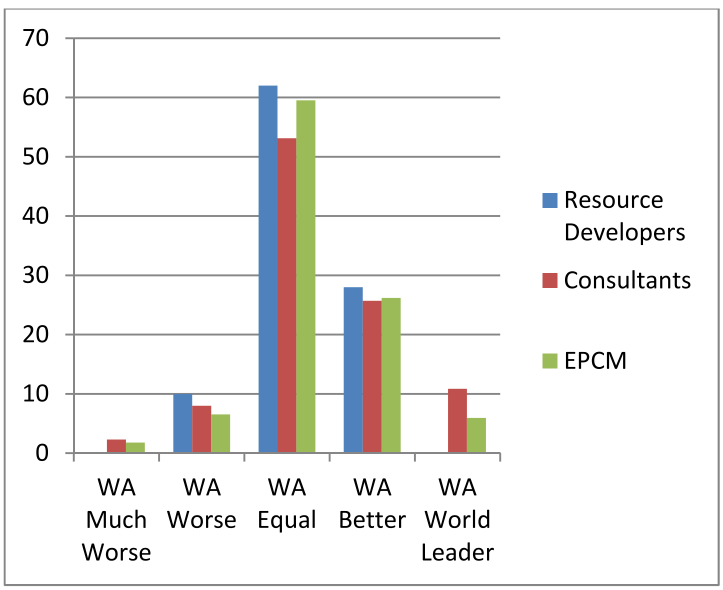


Figure 46- International Comparison of WA's Capability to Undertake FEED

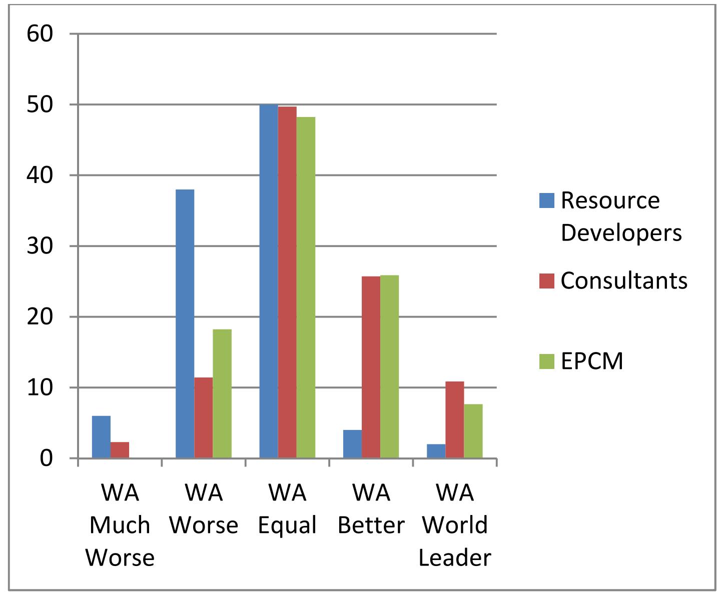


Figure 47- International Comparison of WA's Capacity to Undertake FEED

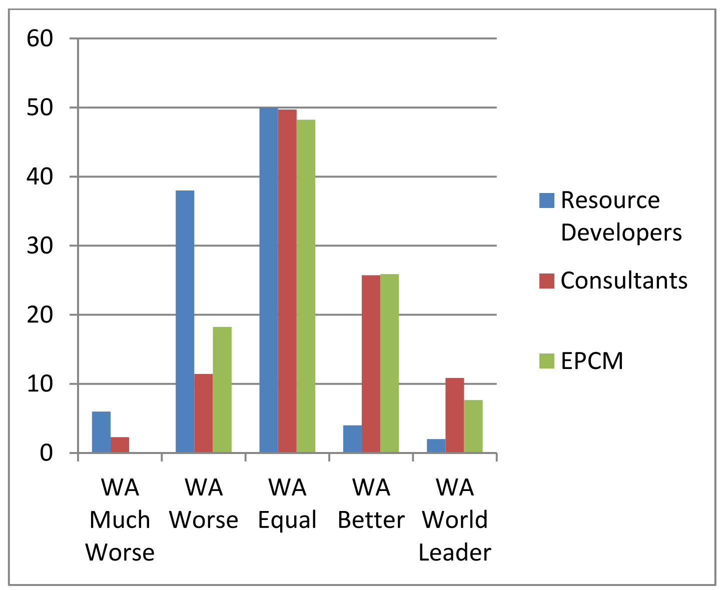


Figure 48- International Comparison of WA's Capability to Undertake Detailed Design

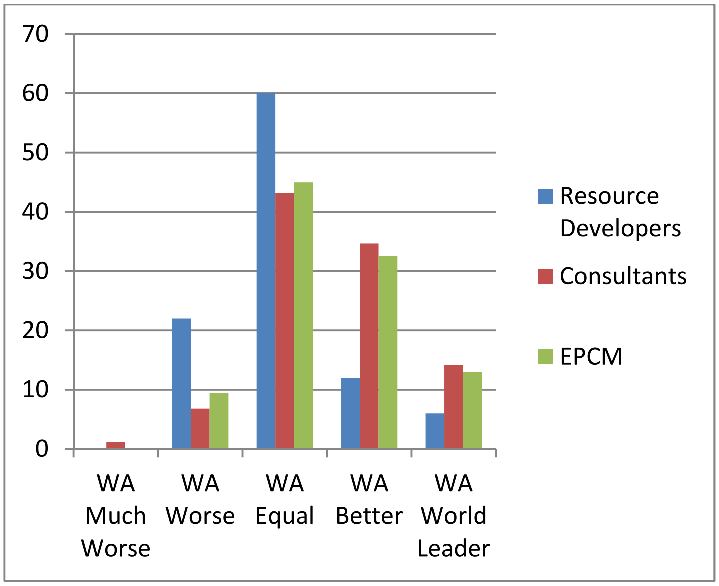
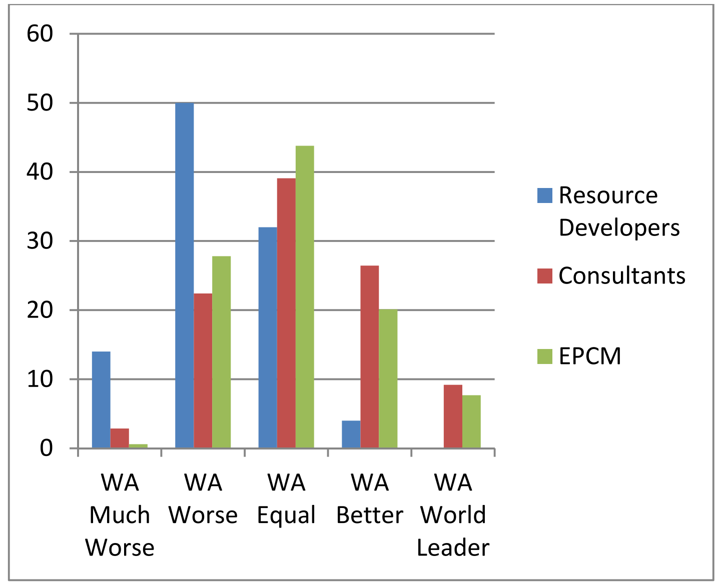


Figure 49- International Comparison of WA's Capacity to Undertake Detailed Design



The figure below provides another insight into WA's international competitiveness. It shows the average salaries for permanent staff for various countries. Australia is now the most expensive country in the world to employ professional engineers. These results are influenced by the exchange rate but as most LNG project transactions are completed in US dollars, the exchange rate and subsequent costs are very important. Given the high Australian costs, it can be expected that international companies would push to undertake as little work in Australia/WA as possible.

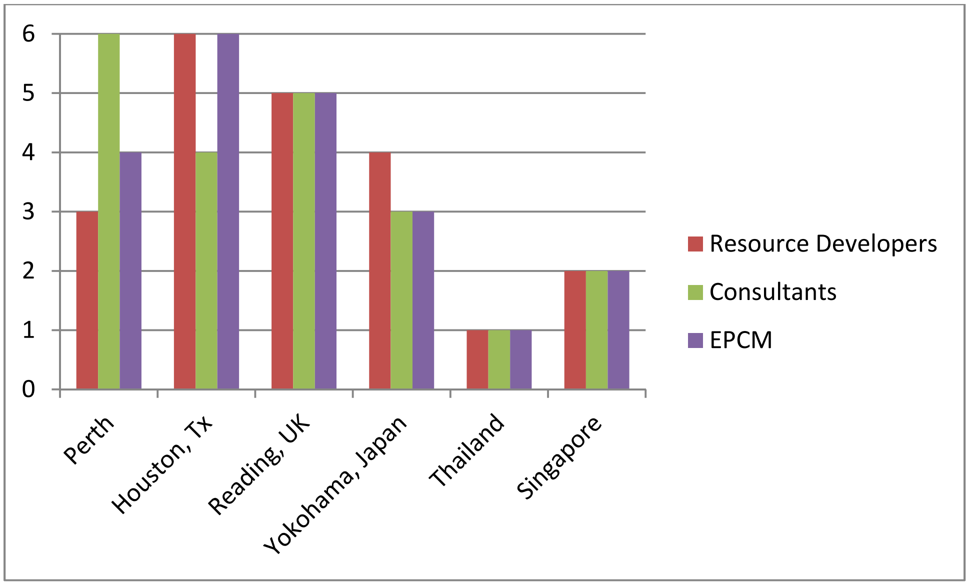
Figure 50- Average Salaries for Permanent Staff

Source: Hays Oil and Gas Salary Survey, 2011

Perth Compared with International Design Centres

To further explore WA's international profile and reputation, respondents were asked to rate various design centres for their ability to undertake engineering design. The design centers included Perth, Houston, Reading, Yokohama, Thailand and Singapore. The results are shown below.

Figure 51- Ranking of Design Centres.



As expected Houston and Reading are considered the pre-eminent design centres in the world. Perth is rated number one by the consultants, but only number four by the Resource Developers.

Section 6 - Policy Considerations

This section provides some policy considerations in relation to high end engineering design in WA. It first summarises the key drivers which are likely to impact on the WA engineering design sector in the foreseeable future. Most of these drivers are based on the strengths and weaknesses of the WA engineering design industry combined with likely barriers to future development. It then provides some policy options to enhance engineering design in WA.

Key Drivers Supporting Development of High End Engineering Design in WA

- Gas and in particular LNG will be an increasingly important source of energy in the foreseeable future.

- LNG projects will become increasingly complex (and more expensive) due to the need to explore for gas in deeper waters and in more remote locations. This will require more specialised skills and resources. Large projects also have a very long project cycle which sometimes could be ten years from first exploration to production. Up front deterrents should therefore be minimised.

- As projects become more complex, front end work will become more important to carefully assess project economics and to inform FID.

- WA has close geographic proximity to large gas fields and is also relatively close to key customers. Being in the same time zone as Asia makes it easier to interact.

- The skills and competencies of WA engineering professionals are highly regarded internationally.

- The initial stages of a project up to FEED are relatively small components of the overall project expenditure- typically around 2-3 per cent. These stages require highly skilled and experienced engineers and drafts people. WA/Australia is capable of providing those services although some supply constraints exist.

- Commonwealth / State Government policies are not seen as inhibiting the development of WA as a design centre. Governments are stable with clear processes and low sovereign risk.

- WA/Perth offer exceptional lifestyle.

- WA has reasonable education / training and research and development facilities although there is scope for enhancement of these facilities.

- Industrial relations considerations are not significant in a highly skilled environment such as engineering design.

- WA, combined with the remainder of Australia, has a substantial pipeline of gas related projects.

Key Drivers Working Against Development of High End Engineering Design in WA

- Technology specialisation and supply chain internationalisation will result in the development of limited key supply bases where maximum comparative advantage can be achieved.

- WA currently lacks the critical mass of other design centres such as Houston and London.

- Australia and WA's record in oil and gas project delivery has not been good with substantial time and cost overruns; this impacts on the perception of the whole sector including high end design.

- The development of FNLG technology can have substantial negative impact on WA given the territorial boundaries between the State and Commonwealth Governments.

- Australia/WA is now regarded as a high cost centre. This is mainly the result of the exchange rate but this is important as most transactions in oil and gas projects are transacted in US$. There is a clear trend to do as much work as possible overseas due to cost and associated factors.

- Industry is experiencing some difficulty in recruiting skilled engineers and this is likely to continue in the near future. There is strong competition with the mining sector for highly skilled engineers in some areas.

- Detailed design is increasingly commoditised and undertaken in specialised low cost centres. WA can no longer compete in that market.

- As projects become more complex, resource developers align more with well-known and trusted EPCM companies which they have worked with previously.

- Propriety technologies are important in LNG project development and form the basis of FEED. These technologies are often associated with particular international EPCM companies, limiting choice to those companies with access to the required technology.

- There are well established oil and gas engineering design centres worldwide which align with major EPCM companies' operations and centres of excellence.

- Commonwealth / State Government policies to attract and retain experienced professionals are not as aggressive as competing governments.

- Individual tax rates are seen as relatively high compared with other countries.

- Currently FEED is undertaken by international design houses and unless FEED is poorly executed, detailed design will often remain with the FEED provider therefore providing limited opportunities for WA / Australian companies.

Potential Policy Considerations

The primary conclusion from the discussion above is that WA has some key advantages in developing engineering design capabilities. It also faces some substantial drivers against promoting engineering design capabilities.

The key take-aways are that:

- WA does not have the capacity to be competitive in detailed design. If any focus is to be placed on design capability in WA it should be on pre-FEED and FEED. WA has the capability to undertake FEED. Some concerns have been expressed about the capacity.

- Activities up to FEED are only a small proportion of a project, typically no more than 2-3 per cent of overall project expenditure. Additionally, FEED only requires a relatively small number of highly skilled professionals. For a typical project it can be 200-300 professionals.

- FEED related expenditure has little impact on the project economics but undertaking FEED well has major impact on project outcomes.

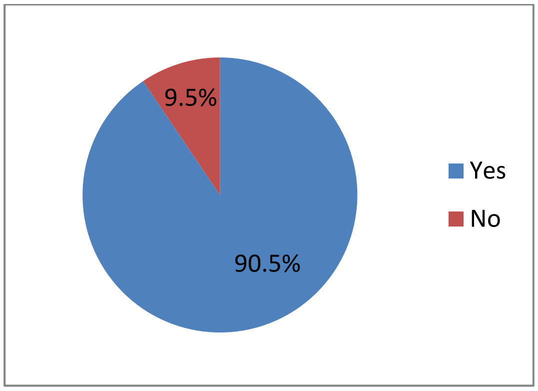
- There is some correlation between where FEED is undertaken and location of subsequent activities. Localisation of FEED can therefore be a catalyst for other local benefits. It has substantial flow on benefits.

- The overall trend in terms of FEED is against WA and substantial ground has been lost. It will take substantial effort to turn the tide around. Given industry trends, relationships and past records it is only through substantial government intervention that this trend will be reversed.

To date negotiations between government and project proponents have had limited success in securing FEED for WA. Since Woodside train 4 there has been limited design undertaken in WA, despite a number of large projects being developed or currently in the pipeline. The overall assessment from industry is that in terms of engineering design, WA has gone backwards.

There is strong desire by industry that the Government should do more to ensure that high end engineering design is undertaken in Perth. There is an overwhelming support for government mandating FEED to be undertaken in WA. Responses to an online question about mandating are shown in the figure below, where 90.5% of more than 400 respondents support government mandating design to be undertaken in WA.

Figure 52- Should Government mandate that FEED be undertaken in WA



Given that the initial high end design up to FEED is very specialized, requires relatively small numbers of highly skilled professionals, is only a small portion of the overall project expenditure and WA has highly skilled human and supporting resources, it can be argued that a special focus on FEED is warranted.

Recommendation 1: During the negotiation with project proponents, Government should have a specific focus on pre-FEED, FEED and associated project management activities and securing these to be undertaken locally.

Although industry supports mandating, a similar positive result should be able to be achieved through appropriate negotiations. Additionally, the use of different approaches such risk sharing or providing incentives should be considered. Incentives could include concessions in relation to research and development, the domestic gas requirement, payroll tax, reduction in royalties or import duties (as through the EPBS scheme) or even income tax reduction as currently being used by other countries.

If it is agreed that FEED should be a substantial focus then it follows that government should proactively ensure that the supply of highly qualified engineers is sufficient. Appropriate education and training and demand driven research and development should be encouraged. WA-ERA could be considered as a mechanism to make this happen.

Recommendation 2: Initiatives be undertaken by both Government and industry to ensure a sufficient supply of highly qualified and experienced design engineers and supporting professionals. These should include education / training as well as demand driven research and development.

Any policy considerations associated with FEED should be undertaken within the overall policy related to local content. The WA government has undertaken a range of initiatives to support local content in general and to improve WA performance relating to engineering design. These include commitment to the principle of full, fair and reasonable opportunity for competitive local suppliers to participate in WA resources projects; Australian Industry Participation Scheme (through Commonwealth Government), State Agreement Acts and the recently announced WA Government Local Industry Participation Framework. The WA Parliament also recently published a discussion paper by the Economics and Industry Standing Committee on The Potential for the Development of a Centre of Excellence in LNG Industry Design in WA.

On a basic level the Government's approach has been to provide an environment which is conducive for private sector to engage in the economic activity of extracting oil or gas (or other minerals). The private sector pays for this privilege through various royalties and taxes. To provide more local benefit the government negotiates with project proponents to achieve a level playing field for local industry.

The Government has recognized that this approach can be improved and has recently launched the WA Government Local Industry Participation Framework. This is a ten point framework based on a broader definition of local content to also include: research and development, regional initiatives, indigenous programs, community support, facilitation of technology transfer, joint ventures, training and skill initiatives and the encouragement of local suppliers into international markets. It also includes increased dialogue between resource owners and government.

Industry cites the success of other governments in securing not only design but also a range of benefits for the local economy. The recent Hebron agreement between the Government of Newfoundland and Labrador in Canada and project proponents (Chevron) is often quoted. The Provincial Government has a view that: 'if it has been built here before, then it can be built here again, if it is started here then it is completed here, and if it is built here, then it is engineered here'. After negotiations the Government extracted substantial agreement which include:

- 4.9% equity stake of the project and profits.
- Additional super royalty of 6.5% on top of the standard 30% to be paid if the oil price rises above US$50 per barrel.
- Fabrication shall take place in the province.
- Minimum of 1.2 million person hours of detailed engineering design work.
- Minimum of 1 million person hours project work to take place in the province.
- US$120m in research and development to be spent in the province.

Although recent initiatives by the State Government are considered steps in the right direction there does not appear to be an overall strategy which could provide an appropriate context for FEED related policy initiatives.

Recommendation 3: That policy initiatives related to FEED be contextualized within an overall industry development strategy for Western Australia.

One of the major issues raised by industry is that the relations between State and Commonwealth Governments often make for ineffective negotiations and outcomes. There is some evidence (from Canada) that a board comprising of both Governments (State and Commonwealth) and negotiating on behalf the two Governments, can be very beneficial in securing maximum local content.

In Canada the proponent is required to create a development plan which has to include a benefits plan and this has to be approved by the board. The benefits plan forms the basis of leverage over the proponents.

An alternative is to establish an expert advisory body which could advise the Minister on local content and industry development issues.

Recommendation 4: That Government considers the appropriateness of a local content board or expert advisory panel which could advise the Minister on local content and industry development issues.

FNLG is a key technology change which is likely to have a substantial impact on the industry. Opportunities in this regard are immense and it is possible for WA to become a global centre of excellence.

Recommendation 5: That the WA Government considers the need to take immediate action to facilitate the establishment of global centre of excellence in FNLG in WA.

Section 7 Conclusions

This report has undertaken a detailed review of WA's capabilities, capacities and competitiveness of high end engineering design in the oil and gas sector (focusing on LNG).

Although WA has substantial advantages in undertaking high end engineering design, the industry has not been successful in securing any substantial work in this regard. The trend is increasingly moving against WA having any sizeable involvement in engineering design. This is disconcerting as undertaking front end engineering design in WA is bound to have substantial flow-on effects.

This trend will only be reversed through substantial government involved and facilitation. FLNG provides a special and immediate opportunity which should not be missed.

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Appendix A

Online Questionnaire

High End Engineering and Design in Western Australia

This project is being undertaken on behalf of the WA Department of Commerce to assess oil and gas engineering and design capabilities in Western Australia.

Note that engineering and design refers to conceptual basic engineering front end and detailed engineering and design associated with oil and gas projects.

WA's ability to undertake High End Engineering

1. How do you rate WA's ability to undertake high end onshore Oil and Gas engineering and design projects in terms of the following factors? (1- Very Low, 5-Very High)

Cost Competitiveness	1	2	3	4	5
Ability to comply with all technical project specifications	1	2	3	4	5
Quality of final design	1	2	3	4	5
Availability of sufficient engineers and support staff	1	2	3	4	5
Being able to deliver within specified time frames	1	2	3	4	5
Appropriate project management skills	1	2	3	4	5
Capacity to undertake the required work	1	2	3	4	5
Access to proprietary technology	1	2	3	4	5
Ability to deliver on budget	1	2	3	4	5

WA's Engineering Capabilities

2. How do you rate WA's engineering capability to undertake the following in relation to high end Oil and Gas projects? (1- Very Low, 5-Very High)

Initial Scoping	1	2	3	4	5
Feasibility Assessment	1	2	3	4	5
FEED	1	2	3	4	5
Detailed design	1	2	3	4	5
Project Procurement	1	2	3	4	5
Project construction management	1	2	3	4	5
Comprehensive EPC/EPCM services	1	2	3	4	5
Risk assessment	1	2	3	4	5

3. In your view is there a particular area or capability in Oil and Gas engineering which WA engineering firms are lacking?

____

____

WA Engineering Expertise

4. How do you rate WA's expertise in the following areas? (1- Poor, 5-Excellent)

Process / Chemical Engineering	1	2	3	4	5
Mechanical / Piping Engineering	1	2	3	4	5
Electronic / Instrument Engineering	1	2	3	4	5
Electrical / Power Engineering	1	2	3	4	5
IT / Telecommunications	1	2	3	4	5
Civil and Infrastructure Engineering	1	2	3	4	5
Structural Engineering (Onshore)	1	2	3	4	5
Structural Engineering (Offshore)	1	2	3	4	5
Subsea Engineering	1	2	3	4	5
Project Management	1	2	3	4	5

WA's Participation in Engineering and Design

5. Does the offshore allocation of FEED impact on the subsequent location of detailed design activities?

   o Yes
   o No

   Why? ______________________________

   ____

6. What can be done to improve WA's participation in high end engineering and design projects? (Particularly work from Concept through to FEED)

   ____

   ____

Trends and Markets

7. Are there any industry trends (positive or negative) which could impact on WA's competitiveness in engineering and design in the future?

   ____

   ____

8. Are there any niche markets / areas which would be beneficial for WA to concentrate on?

   ____

   ____

Training

9. Are there sufficient education and training opportunities to develop engineering and design expertise locally in your firm or in WA in general?

   - o Yes
   - o No

   Comments: ______________________________

   ____

Government Involvement

10. Do you think the government should mandate a particular percentage of local content for high end engineering and design projects?

    - o Yes
    - o No

    Why? ______________________________

    ____

11. What else could the government do to increase the success rate of WA industry in high end engineering and design projects (other than mandating a percentage)?

    ____

    ____

WA Design Engineering in comparison to the Rest of the World

12. In relation to high end engineering design projects, how does WA compare with the world's best? (1-WA Much Worse, 5-WA World's Leader)

Overall technical and engineering expertise	1	2	3	4	5
Size of engineering workforce	1	2	3	4	5
Skill level of engineering workforce	1	2	3	4	5
Productivity of engineering workforce	1	2	3	4	5
Overall capability to undertake engineering and design	1	2	3	4	5
Cost competitiveness	1	2	3	4	5
Quality of design product	1	2	3	4	5
Supporting services (e.g. IT)	1	2	3	4	5
Capability to undertake FEED	1	2	3	4	5
Capacity to undertake FEED	1	2	3	4	5
Capability to undertake detailed design	1	2	3	4	5
Capacity to undertake detailed design	1	2	3	4	5

Opportunities and Barriers

13. How do you rate the following factors in supporting or impeding high end engineering and design being undertaken in WA? (1-Strong Barrier, 5-Strongly Supports)

Legal and regulatory environment	1	2	3	4	5
Tax levels and laws	1	2	3	4	5
OHS laws and regulations	1	2	3	4	5
WTO conventions	1	2	3	4	5
Bilateral trade agreements	1	2	3	4	5
Government industrial development policies	1	2	3	4	5
Labour laws and regulations	1	2	3	4	5
Federal / State Government relations	1	2	3	4	5
Australian sovereign risk profile	1	2	3	4	5

14. What are the barriers to Perth becoming a Centre of Excellence for oil and gas engineering design?

Barrier 1

Barrier 2

Barrier 3

Strengths and Weaknesses

15. Please rank the following centres for their ability to undertake Engineering and Design (1- Best, 6-Worst)

Perth

Houston, Texas

Reading, UK

Yokohama, Japan

Thailand

Singapore

16. What are Perth's strengths as a centre for design excellence (compared with Houston, Reading and Yokohama)?

Strength 1

Strength 2

Strength 3

17. What are Perth's weaknesses as a centre for design excellence (compared with Houston, Reading and Yokohama)?

Weakness 1
Weakness 2
Weakness 3

Demographic Information

18. How many years experience do you have in the Oil and Gas Industry?
    - o 0-5 years
    - o 5-10 years
    - o 10-20 years
    - o 20+ years

19. Who is your employer?
    - o Operator
    - o EPC / EPCM
    - o Contractor / Consultant / self
    - o Other (please specify): ____________________________

20. In which location have you been working mostly during the last three months?
    - o Perth
    - o Elsewhere in WA
    - o Australia (not WA)
    - o International

21. What is your highest formal qualification?
    - o Certificate / Diploma
    - o Bachelor Degree (Engineering)
    - o Bachelor Degree (Other)
    - o Post Grad Degree
    - o No Formal Qualification

Thank You

Thank you very much for your participation in this survey. If you require any additional information please contact:

Dr. Martin West
E: m.west@curtin.edu.au
M: 04111 65494

Appendix B

Company Questionnaire

Government of **Western Australia**

Department of **Commerce**

QUESTIONNAIRE: ENGINEERING AND DESIGN IN THE OIL AND GAS SECTOR

This survey is undertaken by the Department of Commerce to assess the capacity and capability of industry involved in high end engineering design in the oil and gas sector in Western Australia. All responses are strictly confidential. Please Note: If your company is part of a joint venture, please respond on behalf of your company only.

1. How many of the following staff does your company currently employ (fulltime equivalent)?

	Western Australia	**Rest of Australia**
Process / Chemical Engineers		
Mechanical / Piping Engineers		
Electronic / Instrument Engineers		
Electrical / Power Engineers		
IT / Telecommunications Engineers		
Civil Engineers		
Project Managers		
Designer / Drafts People		

2. How many of the following contractors does your company currently employ (fulltime equivalent)?

	Western Australia	**Rest of Australia**
Process / Chemical Engineers		
Mechanical / Piping Engineers		
Electronic / Instrument Engineers		
Electrical / Power Engineers		
IT / Telecommunications Engineers		
Civil Engineers		
Project Managers		
Designer / Drafts People		

3. How many total employees and contractors does your company employ?

   In Perth ____________

   Rest of Western Australia ____________

   Rest of Australia ____________

   Outside Australia ____________

4. Where is your company headquarters located?
   In Australia (Circle Location) WA SA NT VIC TAS NSW QLD ACT
   If overseas, please advise location ____________________

5. What are your company's plans in terms of employing additional professionally qualified engineering staff over the next twelve month?

   Substantial Decrease ___________
   Small Decrease ___________
   No Change ___________
   Small Increase ___________
   Substantial Increase ___________

6. If your company is currently recruiting professionally qualified engineers, how do you find the availability of appropriate candidates?

   Not recruiting ___________
   Severe shortage in some areas ___________
   Some difficulty in finding appropriate candidates ___________
   Somewhat available ___________
   Sufficiently available ___________

7. In relation to high end engineering design projects, how does WA compare with the world's best? (1-WA Much Worse, 5-WA World's Leader)

Overall technical and engineering expertise	1	2	3	4	5
Size of engineering workforce	1	2	3	4	5
Skill level of engineering workforce	1	2	3	4	5
Productivity of engineering workforce	1	2	3	4	5
Overall capability to undertake engineering and design	1	2	3	4	5
Cost competitiveness	1	2	3	4	5
Quality of design product	1	2	3	4	5
Supporting services (e.g. IT)	1	2	3	4	5
Capability to undertake FEED	1	2	3	4	5
Capacity to undertake FEED	1	2	3	4	5
Capability to undertake detailed design	1	2	3	4	5
Capacity to undertake detailed design	1	2	3	4	5

8. Indicate which category applies to your company

   Resource Operator ___________
   EPC/EPCM ___________
   Contractor/Consultant ___________
   Other ___________

Thank you for participating in the survey. Please return your completed questionnaire in the enclosed reply paid envelope prior to Tuesday 28 June 2011.

Appendix C

Quantitative Perspective of the WA Oil and Gas Sector

Introduction

This appendix provides a quantitative perspective on the oil and gas sector in WA. It is based on available official statistics and provides some context for the discussion about the engineering design capability.

Data was obtained from Government departments and agencies, mostly from Department of Education, Employment and Workplace Relations (DEEWR), Australian Bureau of Statistics (ABS) and Education Department of WA. Data collected from the ABS, especially Labour Force Data Cubes (Cat. No. 6291.0.55.003), turned out to be the most useful as it contains aggregate data based on industry division, subdivision and state.

To extract and organise data from ABS Data Cubes, the Australian and New Zealand Standard Industry Classifications (ANZSIC) was used. Five industry divisions were selected to represent the WA's oil and gas industry (see Table C.1).

Table C.1 Five selected sector representing WA's oil and gas industry

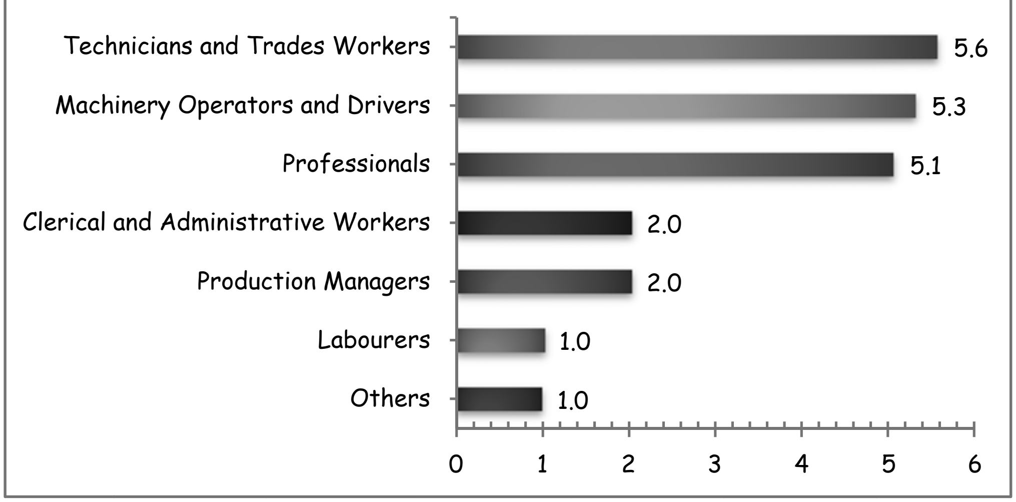
Oil and gas extraction (Class 0700)
Group 07, Subdivision Oil and Gas Extraction, Div. B Mining Activities: producing crude oil, natural gas or condensate through the extraction of oil and gas deposit.
Petroleum Exploration (Class 1011)
Group 101 Exploration, Subdivision 10 Exploration and Other mining support services, Div. B Mining Activities: consist of natural gas and petroleum exploration
Other Mining Support Services (class 1090)
Group 109 Other mining support services, Subdivision 10 Exploration and Other mining support services, Div. B Mining. Activities: include cementing oil and gas well castings, directional drilling and redrilling, mining draining and pumping service, oil and gas field support service
Industrial Gas Manufacturing (class 1811)
Group 181 Basic chemical manufacturing, Subdivision 18 Basic chemical and chemical product manufacturing, Div. C Manufacturing. Activities: include liquefying natural gas
Petroleum Refining and Petroleum Fuel Manufacturing (class 1701)
Group 170 Petroleum Refining and Petroleum Fuel Manufacturing, Subdivision 17 Petroleum and coal product manufacturing, Div. C Manufacturing Activities: include refining heavy and light component crude oil

Source: ABS cat. no. 1292.0 – ANZSIC 2006 Revision 1.0

Occupation

As of February 2011, the majority of workers in WA's oil and gas industry were technicians and trade workers (5,600), followed by machinery operators and drivers (5,300). Professionals (including design engineers) made up 23% (5,100) of the total work force.

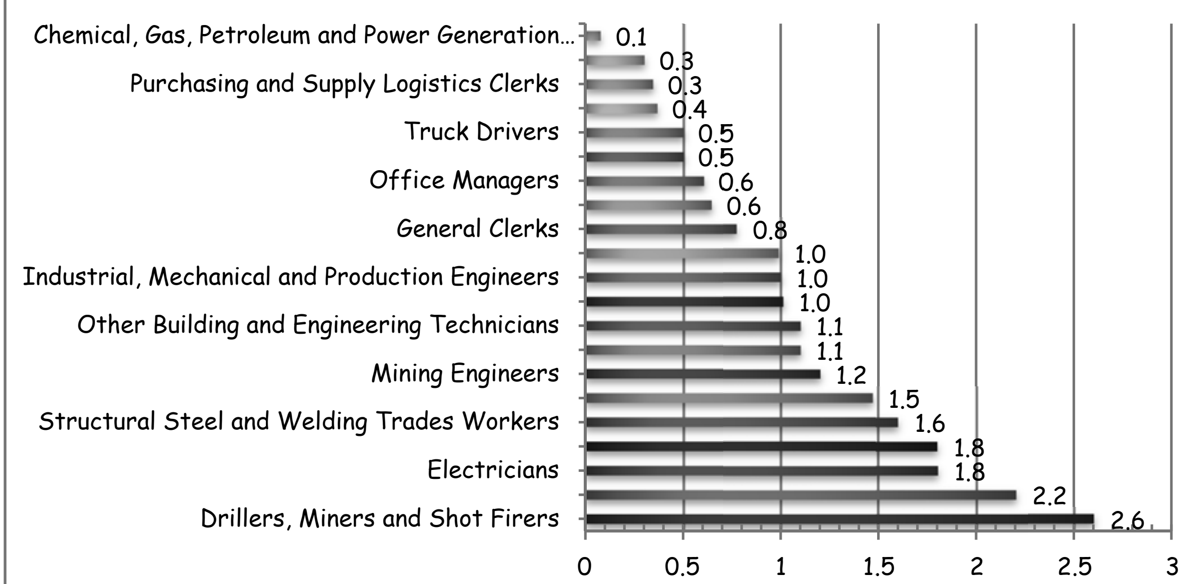
Figure C.1 Employing occupations ('000) - Feb 2011



Source: ABS cat. no. 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly (Feb 2011)

Using different categories, Figure C.2 shows that the majority of workers are Drillers, Miners and shot firers (2,600), followed by Metal fitters and machinists (2,200) and electricians (1,800).

Figure C.2 Employing occupations ('000) - Feb 2011

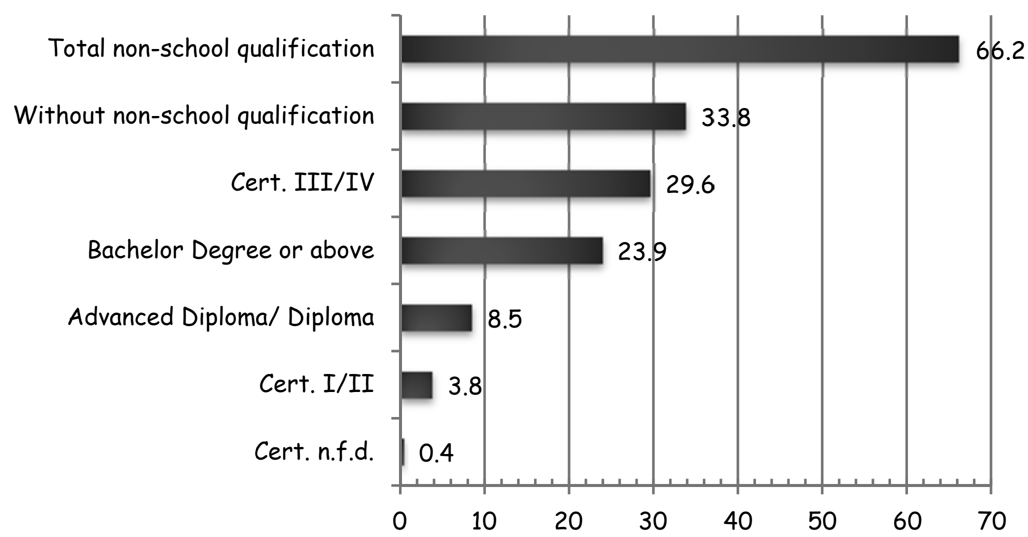


Source: ABS cat. no. 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly (Feb 2011)

Educational Profile

As of February 2011, almost two third of workers (66.2%) in WA's oil and gas industry had completed a post-secondary school qualification. Most have completed a Certificate III or IV (29.6%), followed by those with Bachelor degree or above (23.9) and Advance diploma or diploma (8.5%). More than one-third of workers (33.8%) are without non-school qualifications.

Figure C.3 Educational attainment (% share) - Feb 2011

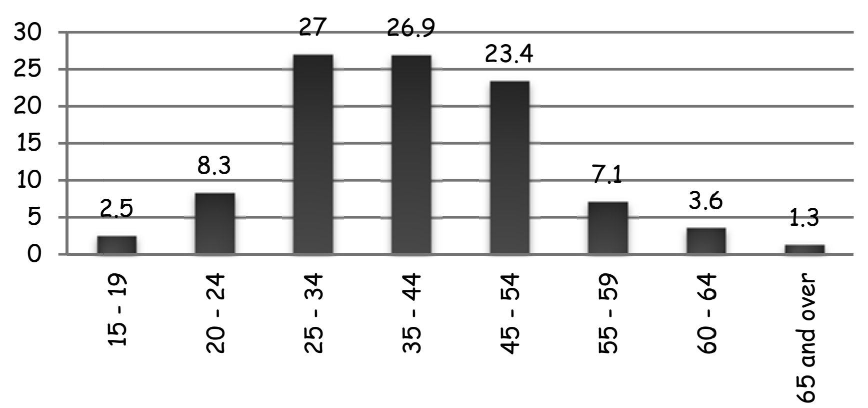


Source: ABS cat. no. 6227.0 Education and Work and 6291.0.55.003.

Workforce Age

Most of the workers in WA's oil and gas industry are in the age range of 25-34 years (27%) and 35-44 (26.9%). Also, there are a significant number of workers in age range 45-54 (23.4%). It shows that almost 54% workers in WA's oil and gas industry are those in the 'prime age' (25-44 years), with a relatively small number outside of this age range.

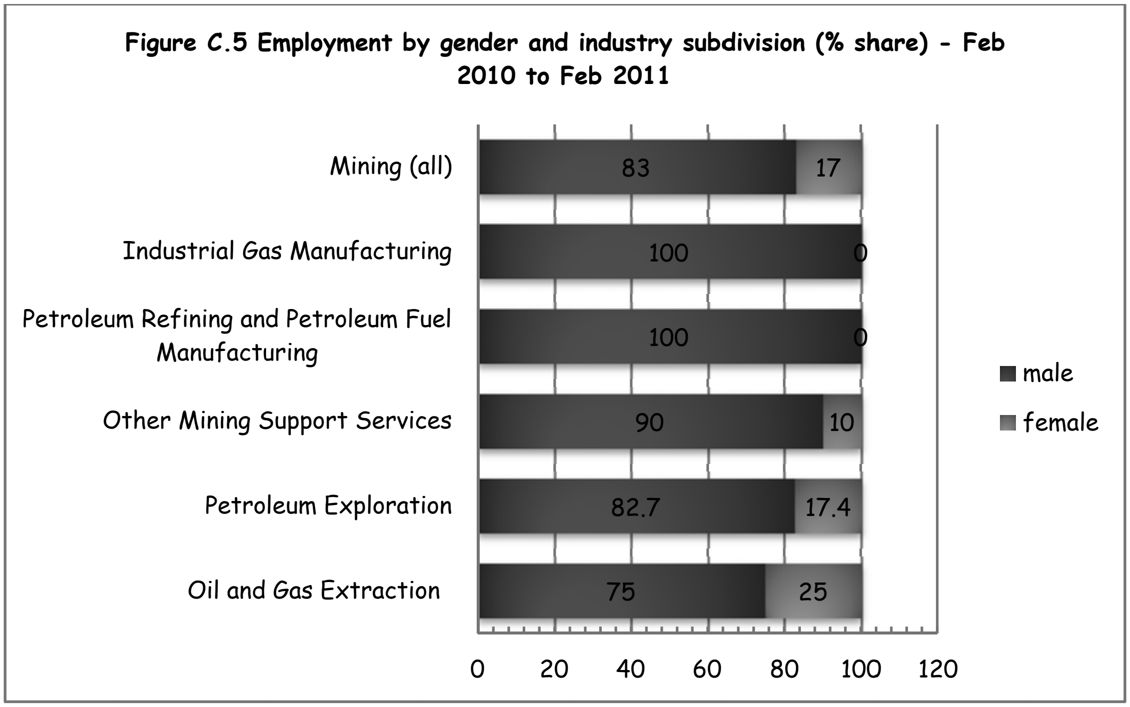
Figure C.4 Employed persons by age (% share of employment) - Feb 2011



Source: ABS cat. no. 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly, Feb 2011

Employment by gender

Figure C.5 shows that in 2010 females made up 25% of workforce in oil and gas extraction and 17.4% in petroleum exploration. Overall, females are around 10% of workforce in oil and gas industry, lower than that in mining industry (17%).

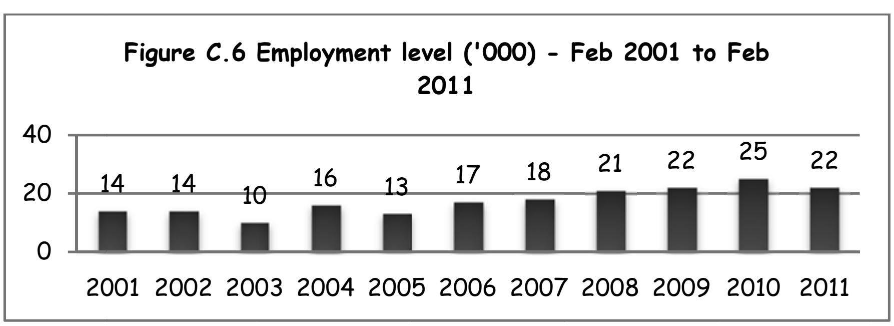


Source: ABS cat. no. 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly, Feb 2011

Employment growth

According to government data, employment in oil and gas industry is influenced by both domestic and international economy, including fluctuation of exchange rate, fluctuation in oil price and international demand (DEEWR 2011).

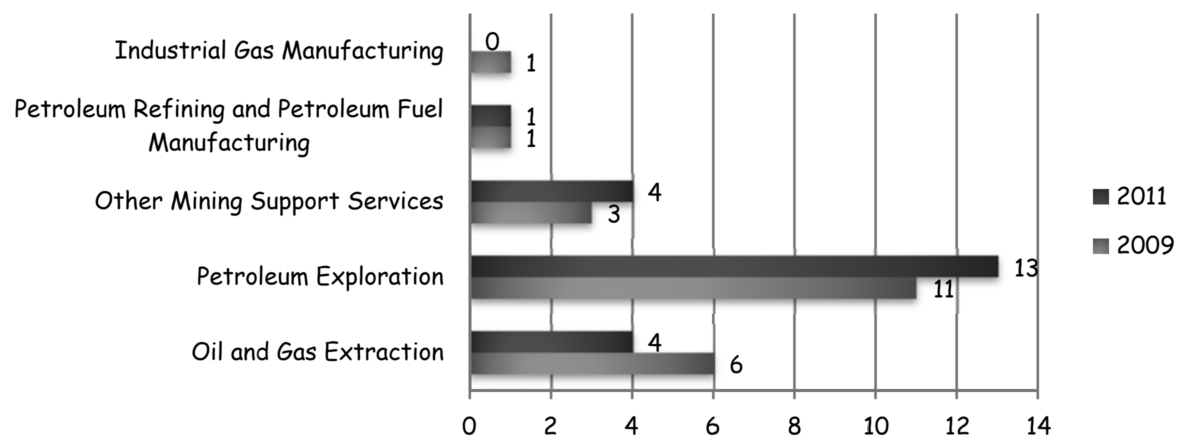
Despite of the strong growth in the previous years, 2011 recorded a 12% decline in employment from 25,000 in 2010 to 22,000 (Figure C.6). This decline is related to global economic slowdown. In five years to 2011, the oil and gas industry in WA experienced 5.9% average annual growth, increasing from 17,000 in 2006 to 22,000 in 2011.



Source: ABS cat. no. 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly, Feb 2011

To identify the main contributor to the employment growth, data has been categorised into five main subdivisions with respect to ANZSIC: oil and gas extraction, petroleum exploration, petroleum refining and petroleum fuel manufacturing, industrial gas manufacturing and other mining support services (ABS 2011). Figure C.7 shows that the main contributor is petroleum exploration (59.1%), followed by oil and gas extraction (18.2%) and other mining support services (18.2%). The smallest proportion of employment comes from petroleum refining and petroleum fuel manufacturing (4.5%) and industrial gas manufacturing. Even the latter sector has been experiencing a decline since 2009.

Figure C.7 Employment level by oil and gas industry subdivision ('000) - Feb 2009 and Feb 2011

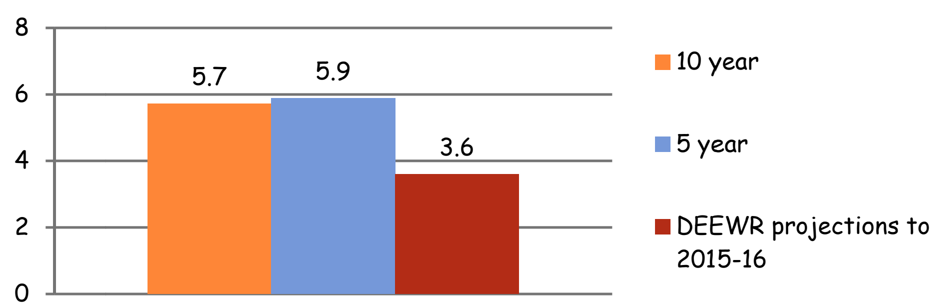


Source: ABS cat. no. 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly, Feb 2011

Employment prospects

According to the latest data from Department of Education, Employment and Workplace Relation (DEEWR), the growth in WA's oil and gas industry is projected to reach 3.6% per year by 2015-2016. This projection is lower than recent growth trends in the industry, which is 5.9% in the last five years and 5.7% in the last ten years.

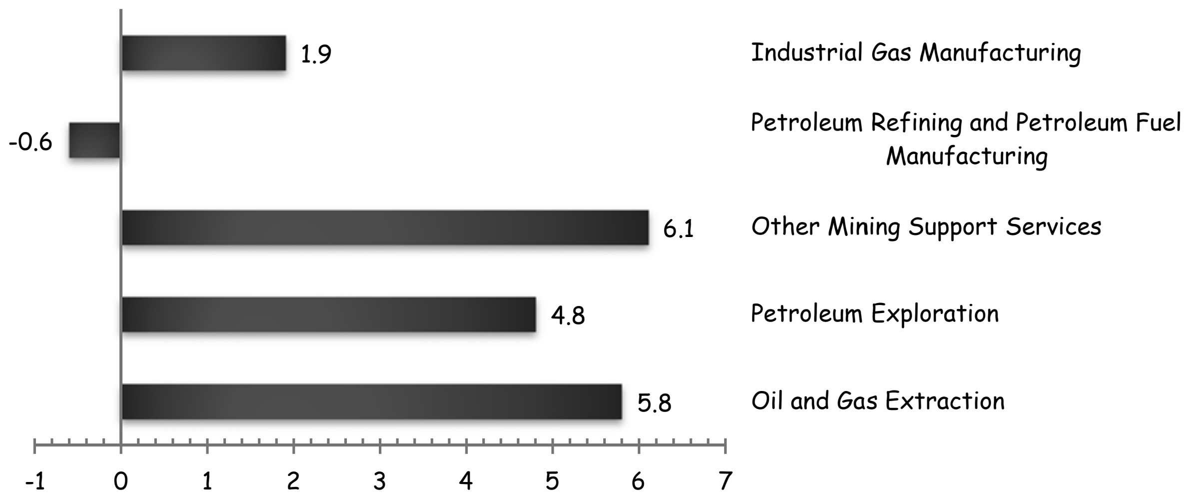
Figure C.8 Recent and projected employment growth (% pa) - to Feb 2011



Source: ABS cat. no. 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly, Feb 2011; DEEWR projections to 2015-16

Further, DEEWR expects that the growth will be varied in the five sector subdivisions (Figure C.9). The strongest growth is projected to take place in other mining support services (6.1% pa), followed by oil and gas extractions (5.8% pa) and petroleum exploration (4.8% pa). However, petroleum refining and manufacturing is projected to decline by 0.6% pa, while industrial gas manufacturing is projected to grow by 1.9% pa.

Figure C.9 Employment growth projections (% pa) to 2015-16

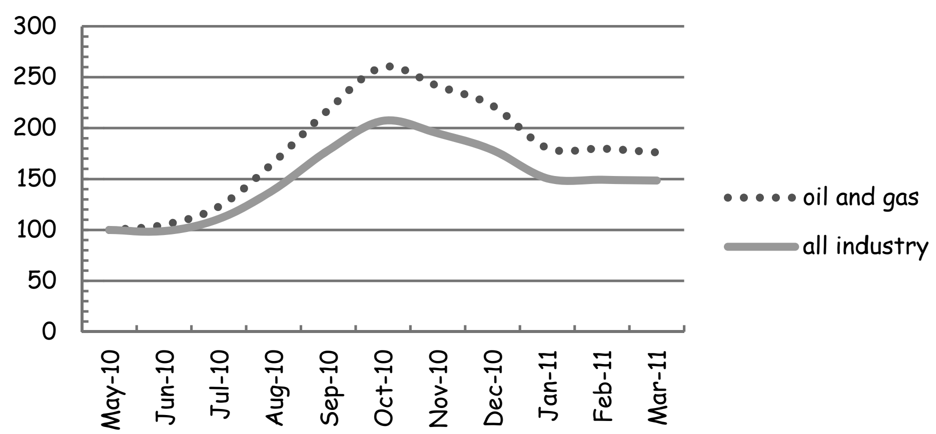


Source: ABS cat. no. 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly, Feb 2011; DEEWR projections to 2015-16

Vacancy trends

Data of vacancy trends across Western Australia are issued monthly by DEEWR in form of Internet Vacancy Index (IVI). This index is developed from the amount of online vacancies lodged on SEEK, MyCareer, CareerOne and Australian JobSearch. Figure C.10 shows that after a peak on October 2010, the vacancies in WA’s oil and gas industry decreased until March 2011.

Figure C.10 Vacancy index in oil and gas sector WA - May 2010 to March 2011

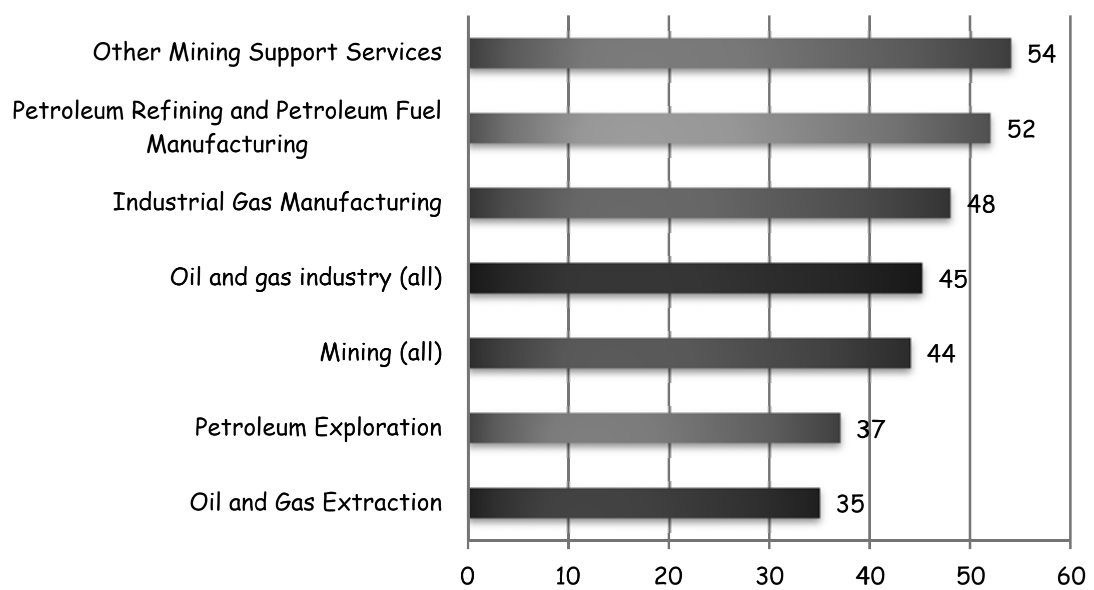


Source: DEEWR internet vacancy index (IVI) 2011

Hours worked

According to ABS, by February 2011 the average work week for a full-time worker in WA's oil and industry is 45%, slightly higher than that in mining industry (44%) (ABS 2011; DEEWR 2011). Figure C.11 shows that among all the industry subdivisions, workers in 'other mining support service' work in the longest hours: 50 hours per week, reflecting the nature of work in this industry.

Figure C.11 Hours worked by industry subdivision (average hours per week) - Feb 2011

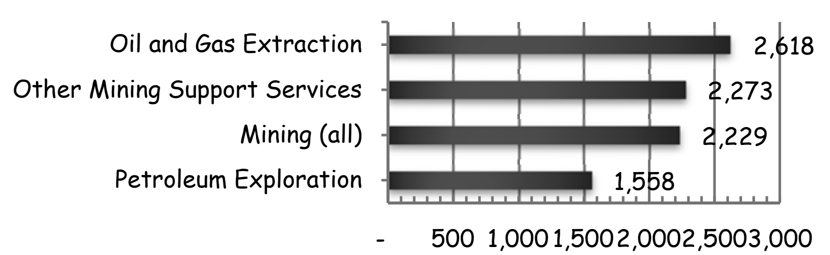


Source: ABS cat. no. 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly Feb 2011; DEEWR, 2011

Weekly Earnings

According to ABS, by May 2010 workers in oil and gas extraction had earned average of $A 2,618 per week, the highest among other oil and gas industry subdivisions, and higher than average weekly earnings in mining industry (see Figure C.12). Workers in petroleum exploration earned the lowest amount ($A 1,558). This figure reflects the intensity and nature of works in the respective industry subdivision, that considerably high amount of wages are given proportionally in return for high risk and demanding work.

Figure C.12 Weekly earning (average, $A) - May 2010



Source: ABS cat. no. 6306.0 Employee Earnings and Hours (May 2010)

Conclusion

In 2011, WA's oil and gas industry experience a slight decline. However, it is projected to experience 3.6% average growth of per year to 2015-16. Amongst all industry subdivision, the fastest growth will be experienced by two sectors: field support services and oil & gas extraction.

In terms of gender, the employment in the sector is dominated by male employees, while female employees only made up around one-tenth of available full-time jobs. This is due to the nature of work in oil and gas industry which is physically demanding and relatively hazardous. This reasoning also explained the evidence that most of employees are in 'prime-time age', who work more than 45 hour per week and earn as much as $A 2,618 per week in average.

Across the industry, most of employees are those worked as drillers, miners and shot firers, followed by electricians, structural steel and welding workers. The employee are mostly worked and resided in Greater WA region and North Metro area of Perth.

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