

Assistance on Liquefied Natural Gas Import Options for Myanmar Phase 1:

Presentation of Final Report

January 2017

MJMEnergy Ltd

www.mjmenenergy.com

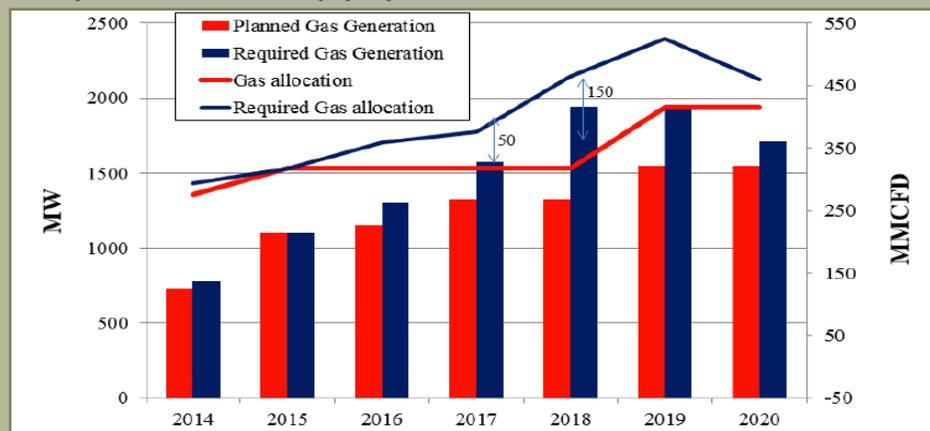
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Section 1: Introduction

Background

- Overview of the Myanmar gas market.
 - Energy consumption is among the lowest in the world, 70% of the population have no access to electricity.
 - Consumption per capita is around 160 kWh per annum, 20 times less than the world average.
 - Only 16% of rural areas have power grid access.
- Gas fired power generation demand is growing
 - Indigenous gas production is constrained due to years of under investment. Resulting in a potential supply/demand deficit.



Possible gas supply options for Myanmar

With this supply/demand deficit, there are 3 options.

Option 1 - importing LNG to supplement domestic gas while new gas exploration gets underway.

Option 2 - Myanmar's swapping LNG with local gas.

Option 3 – Supply options can include cooperation with neighboring countries on bilateral / regional gas trade, to jointly benefit from existing and future natural gas supply/import infrastructure.

Objectives of this project

- Providing support to the Government of Myanmar (GoM) in developing a gas sector development plan by focusing on the near-to-medium term options to meet the gas demand in Myanmar.
- Focusing on gas import options related to LNG, which could initially be used as a bridging fuel while new gas exploration gets underway in Myanmar.
- In particular, the focus is on the possibilities for LNG receiving facilities in Myanmar, which given the proposed timescales suggest prospects for development of floating regasification LNG terminals.
- In particular, this project will be focused on three key tasks, Tasks 1(a), 1(b) and 1(c) which are summarised in the right hand panel.

Key deliverables for this project

Task 1(a) – Siting analysis to assess potential locations of LNG import facilities in Myanmar.

Task 1(b) – Development of a prioritisation framework and accompanying analytical tool for LNG import options and locations.

Task 1(c) – Prepare an overview of the LNG markets that Myanmar may access with a view of procuring LNG to be physically swapped with gas export partners

The MJMEnergy Team

- MJMEnergy have developed a bespoke Project Team as follows:
- **MJMEnergy** is a UK-based firm providing technical and commercial consultancy throughout the world with a clear focus on natural gas and LNG related projects.
- **Penguin Energy Consultancy (PEC)** is a UK-based, independent energy industry techno-commercial consultancy and training provider. PEC has been involved in 46 LNG projects in 28 countries over 20 years, In addition PEC will be assisted by CA Metocean consultants
- **Economic Consulting Associates Limited (ECA)** was formed in 1997 to provide economic and regulatory consulting services to industry and government. ECA specialises in advising on economics, policy and regulatory issues in the utilities industries, with particular expertise in the gas sector.
- **Drennan Marine Consultancy Ltd** - is an LNG marine specialist with experience working in over 20 countries worldwide and is well used to ranking multiple locations in a structured and consistent way against relevant marine criteria including natural shelter, navigational risk and the capability of local services.

Members of the consortium



Section 2: Key Issues

Key Issues – Schedule and duration

- The economy has been growing and demands more electricity.
- Current hydroelectric capacity is limited.
- Gas fired power generation demand is growing.
- Significant quantities of Myanmar's gas is sold to Thailand and China.
- There is an impending gas shortage in Myanmar.
- MOGE is under considerable pressure to provide additional gas.
- Myanmar's upstream sector is exploring for new supplies but schedule is mid term to long.
- LNG is needed to provide a bridging solution.
- The need is urgent.
- The contract duration is uncertain depending on the success of offshore drilling.

Key Points

There is considerable pressure on the MOGE to resolve its gas shortage quickly.

Whilst additional supplies of gas from Myanmar's upstream resources should be available this may take longer than expected.

LNG is needed as bridging solution but the duration of the supply is uncertain.

Key Issues - Metocean environment

- Successful commercial operation requires the LNG facility to operate for a very high percentage of the year (typically >97%). This requires the LNG facility to
 - Remain connected to the gas export pipework and be able to offload LNG from LNG carriers on schedule.
- Metocean conditions (wind and wave) are the main external factor in determining availability and operability.
 - Coastal waves were simulated using numerical modelling at each location.
 - 20 years long time series of wave height, wave direction, wave period, wind speed and wind direction were derived to assess the level of exposure.

Key points

Met-ocean analysis is key to the site selection



Key Issues - Social, cultural and environmental issues

- Also key in deciding the suitability of each site will be the inclusion of the following factors:
 - Impact on sensitive environmental areas such as national parks, marine reserves, coral and mangrove forests, etc.
 - Impact on community issues such as fishing grounds and tourist areas (revenue generation).
 - Impact on culturally sensitive sites such as temple complexes, sports stadia etc.
- Maps, internet resources and guide books have been consulted to establish headline impacts, if any.
- External project financing will be contingent on good environmental performance.

Key Points

The Social, cultural and environment assessment is at a very high level and only uses publically available data.

Good environmental performance is key to project financing.



Key Issues – Weather and geology

➤ Weather

- Weather systems primarily come to the coast of Myanmar from the south west.
- The south west monsoon can produce high winds and flooding.
- Cyclones are a regular feature of Myanmar's weather.

➤ Geology

- Myanmar sits on the borders of 3 tectonic plates.
- Earthquakes caused by plate movement and active faults are common.
- Some volcanic activity is also present.

Key Points

Severe weather can be expected during the lifetime of the LNG facility.

A significant earthquake is possible during the lifetime of the LNG facility.



Key Issues - Local infrastructure

- An LNG facility needs local infrastructure to be able to be constructed, maintained & operated:
 - Tugs able to move and position the LNG carrier at the LNG facility.
 - Roads or marine transport able to deliver construction equipment and material, operating consumables and provide access for staff and vendor representatives.
 - Availability of ports able to provide services such as pilotage, importation of equipment etc. and have appropriate rules and experience of hydrocarbon operations.
 - Access to skilled people to operate or support the LNG facility or the ability for expatriates to access the facility.

Key Points

Myanmar has limited local infrastructure and much of the required capabilities are remote from the proposed site.



Key Issues – Cost and ownership

- An LNG facility and the associated importation contract is likely to be the largest investment Myanmar has made.
- Some technology options may be leased rather than purchased to reduce impact.
 - Leasing reduces control.
 - BOT/BOOT options may be available.
- Capital investment in owned facilities may be large compared to the potential duration of the LNG import contract.
- Capital and operating (including leasing) costs need to be analysed on the same basis.

Key Points

Capital and operating costs need to be analysed on the same basis.



Key Issues – Storage capacity and vaporisation rates

- LNG delivery may be delayed by bad weather or gas vaporisation may exceed norms leading to a shortage of LNG.
- Some storage margin within the LNG facility to keep gas export/power generation running is important.
- Storage is expensive.
- Security of supply/storage margins are a political issue and should be set by MOEE.
- Vaporisation capacity is relatively inexpensive and therefore not considered a key issue.

Key Points

Security of supply needs to be set by MOEE.

LNG storage is expensive.

Vaporisation capacity is inexpensive and not a key issue.

Section 3: Site Selection

Methodology

A three level selection methodology has been used:

- Stage 1 (Concept selection) – Technology concept selection is based on overriding system performance requirement. (Schedule and ownership, etc.)
- Stage 2 (Qualitative selection) – A qualitative tool based on traffic lights provides preliminary scoping of a range of sites.
- Stage 3 (Discounted expenditure selection) – A simple discounted expenditure tool which allows both capital costs and operating costs to be compared simultaneously is used to provide the 3rd stage of selection.

Key Points

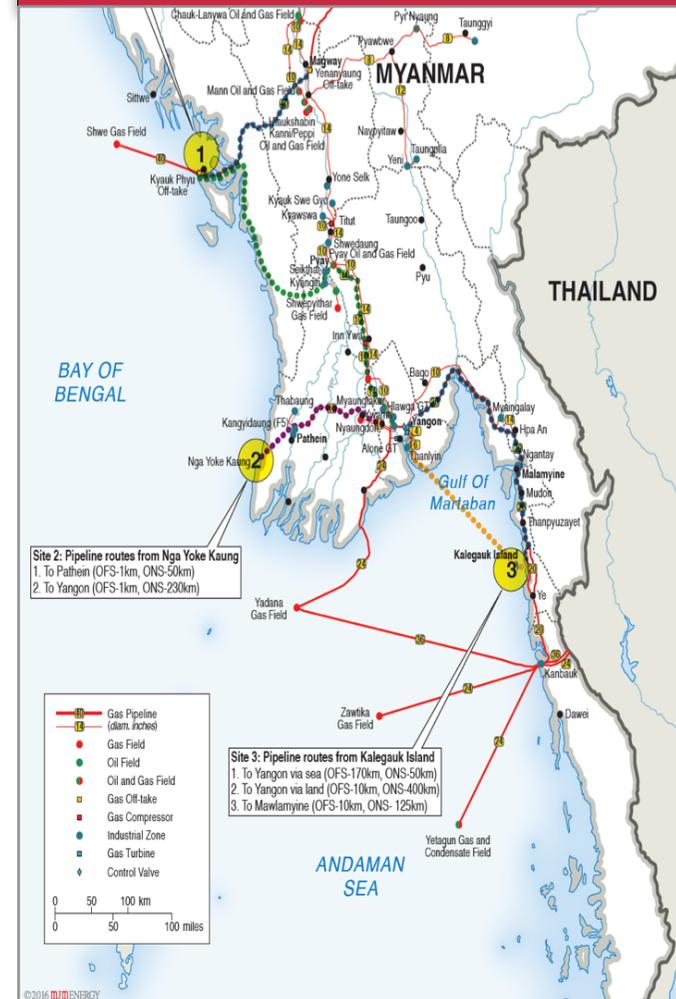
A three level selection process which improves in granularity as it progresses.



Site overview

- MOGE requested that 3 general areas were examined for suitable LNG import sites as shown below:
- Kyauk Phyu in Rakhine state.
 - 2 sites reviewed on the Madegyan River.
- Nga Yoke Kuang in Ayeyarwady state.
 - 2 sites onshore in Ngayok Bay.
 - 2 sites offshore in mid depth and deep water.
- Kalegauk Island in Mon state.
 - 1 site onshore on the east of the island.
 - 1 site offshore in mid water to the northwest of the Island.

Site Options

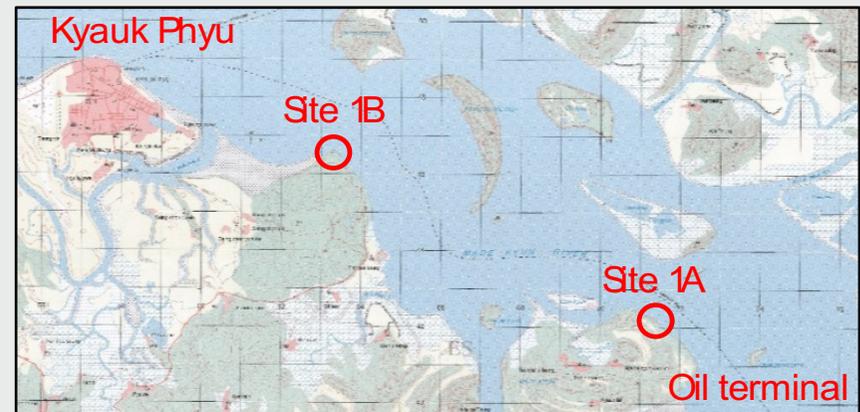
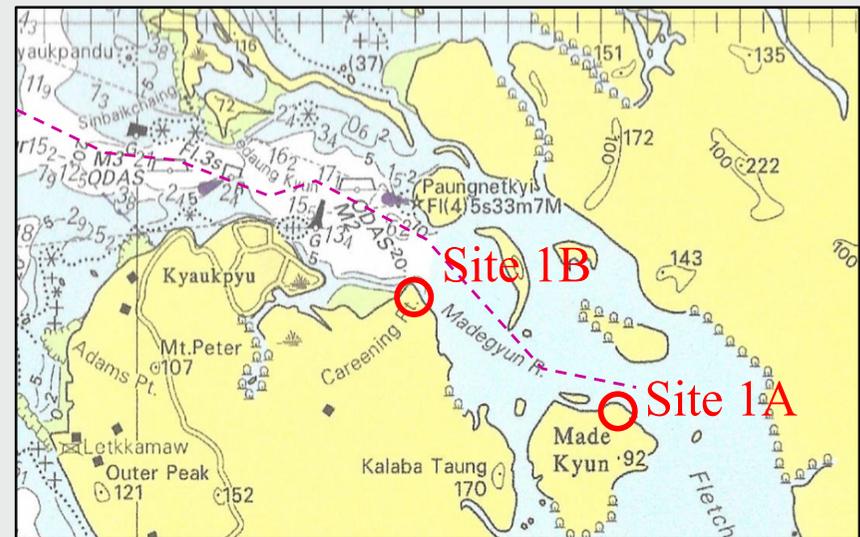


Section 4: Site 1 Kyuak Phyu

Site 1: Kyauk Phyu overview

- Two sites considered on the Madegyan River to the south east of Kyauk Phyu
 - Site 1A on Made Island close to or adjacent to the Shwe Oil Terminal.
 - Site 1B on Ramree Island close to the Naval Base at Careening Point.

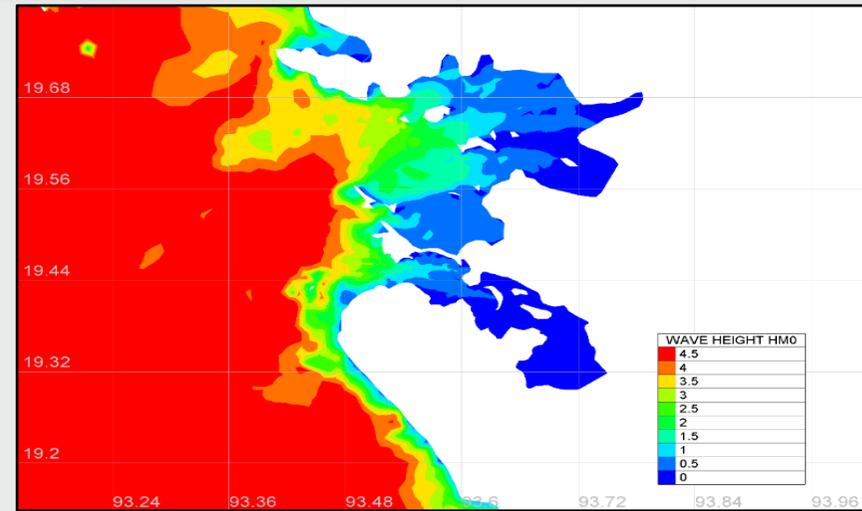
Site 1: Kyauk Phyu overview



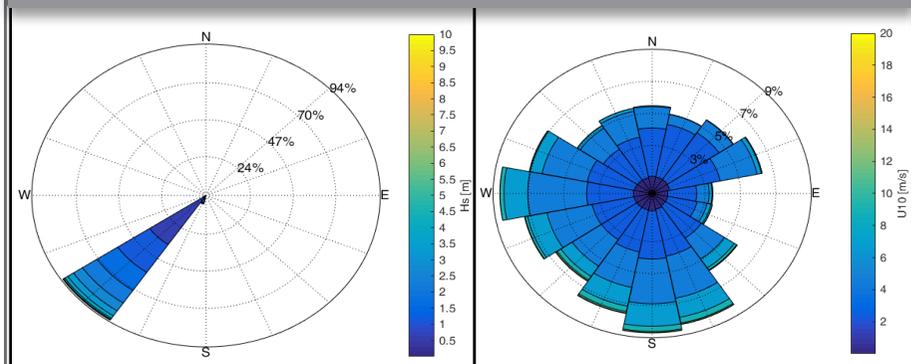
Site 1: Metocean analysis

- Both sites are well sheltered by Ramree Island from the prevailing SW wind and monsoon.
- Non cyclonic storms will not affect the LNG facility.
- Winds are insufficient to challenge LNG carrier mooring guidelines.
- A very good marine site

Non Cyclonic Storm

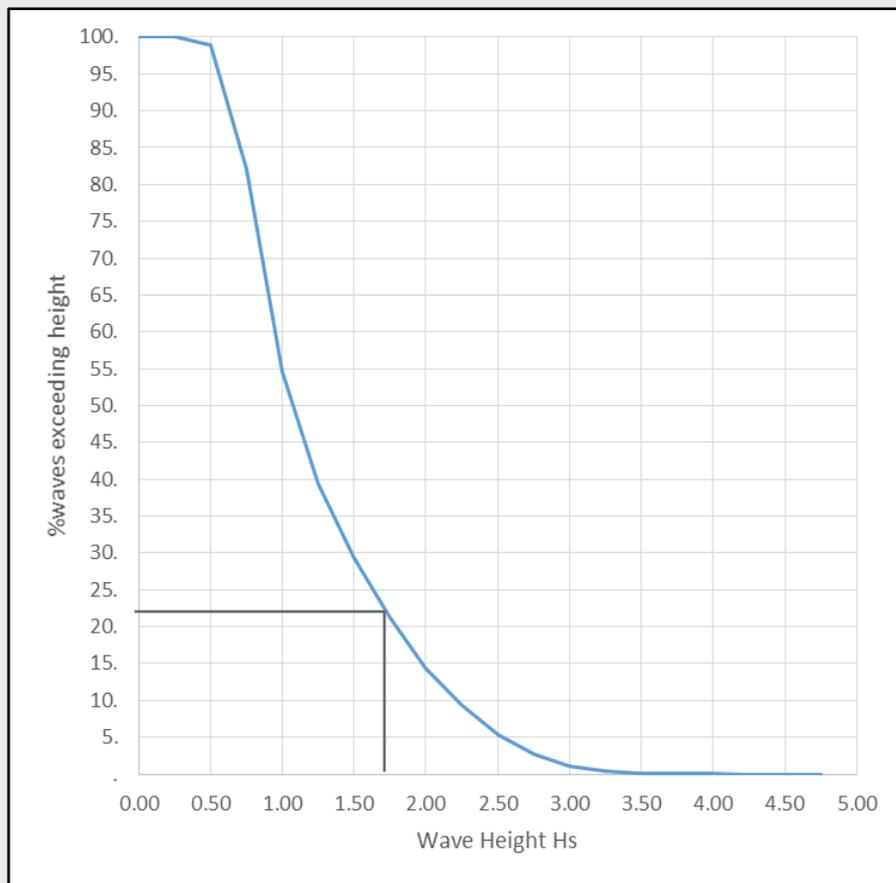


Wave & wind rosettes

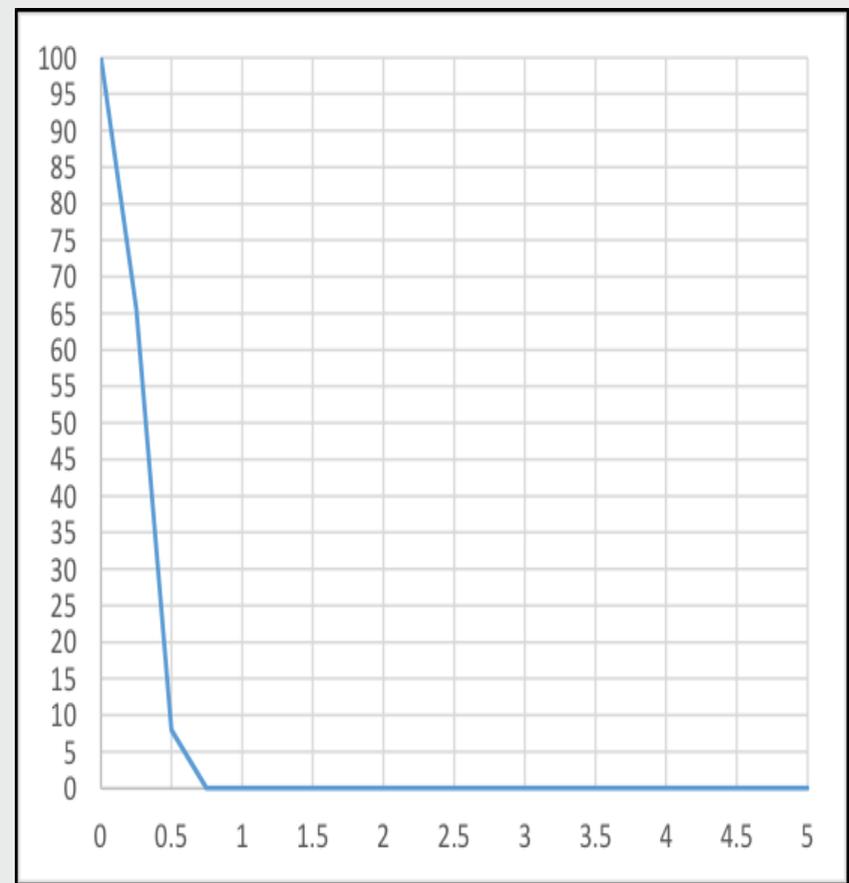


Site 1: Metocean analysis

% Wave exceedance At the pilot station



% Wave exceedance At the berth

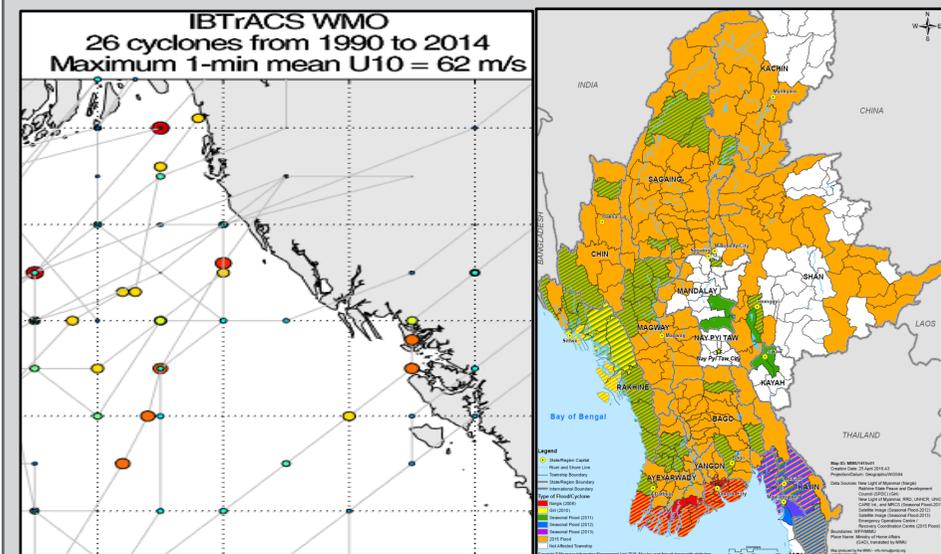


Site 1: Weather & Geology

Weather

- Cyclones are prevalent in Northern Myanmar and should be expected.
- Flooding has occurred twice since 2010.

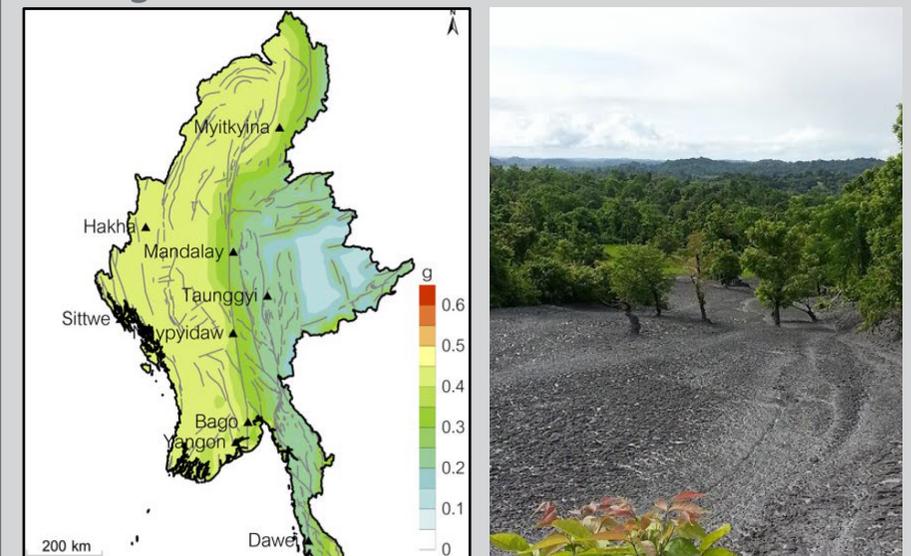
Cyclone tracks & flooding events



Geology

- Magnitude 4 and 5 earthquakes have occurred nearby.
- High peak ground accelerations are anticipated (0.4 – 0.45g).
- Sai Krone mud volcano near Site1B.

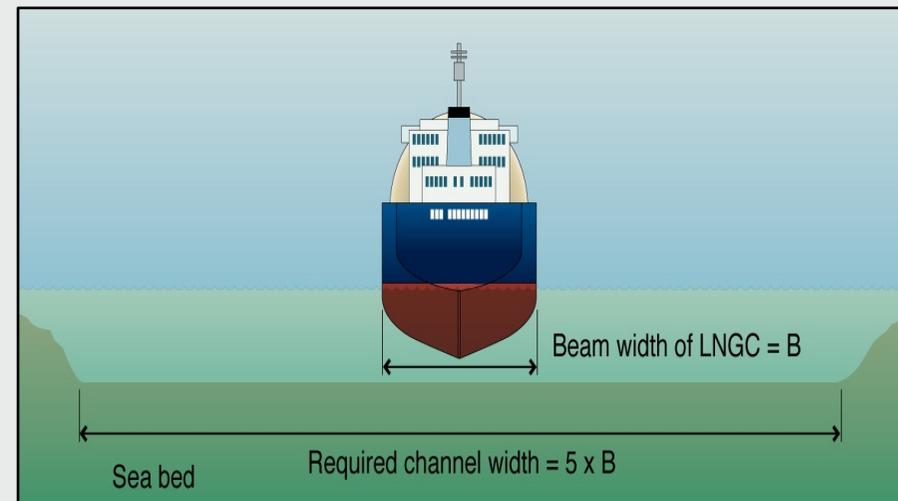
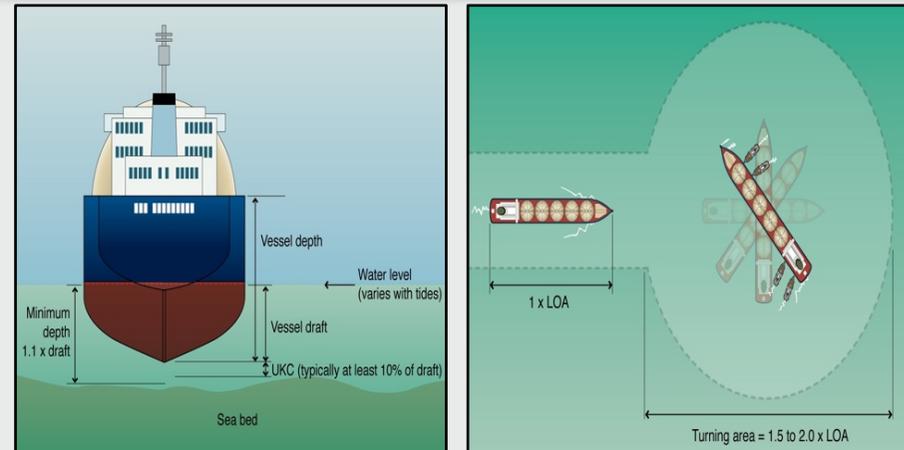
Peak ground accelerations Sai Krone



Site 1: Navigation analysis

- A deep water channel to the oil terminal already exists and is large enough for LNG carriers.
- The required Jetty is relatively short but it should be optimised with the minor dredging required to make a berth pocket out of the main channel.
- No wave protection required.
- A good marine site.

Navigation requirements



Site 1: Environmental, Social & Cultural Impact

- Mangrove is definitely present in Combermere Bay. Coral and seagrass may be present.
- The oil terminal has upset local residents who have made environmental and economic claims.
- Protests against development should be expected.
- Anecdotal comments about issues around the oil and gas pipelines.

Environmental impacts

Mangrove areas around Kyauk Phyu

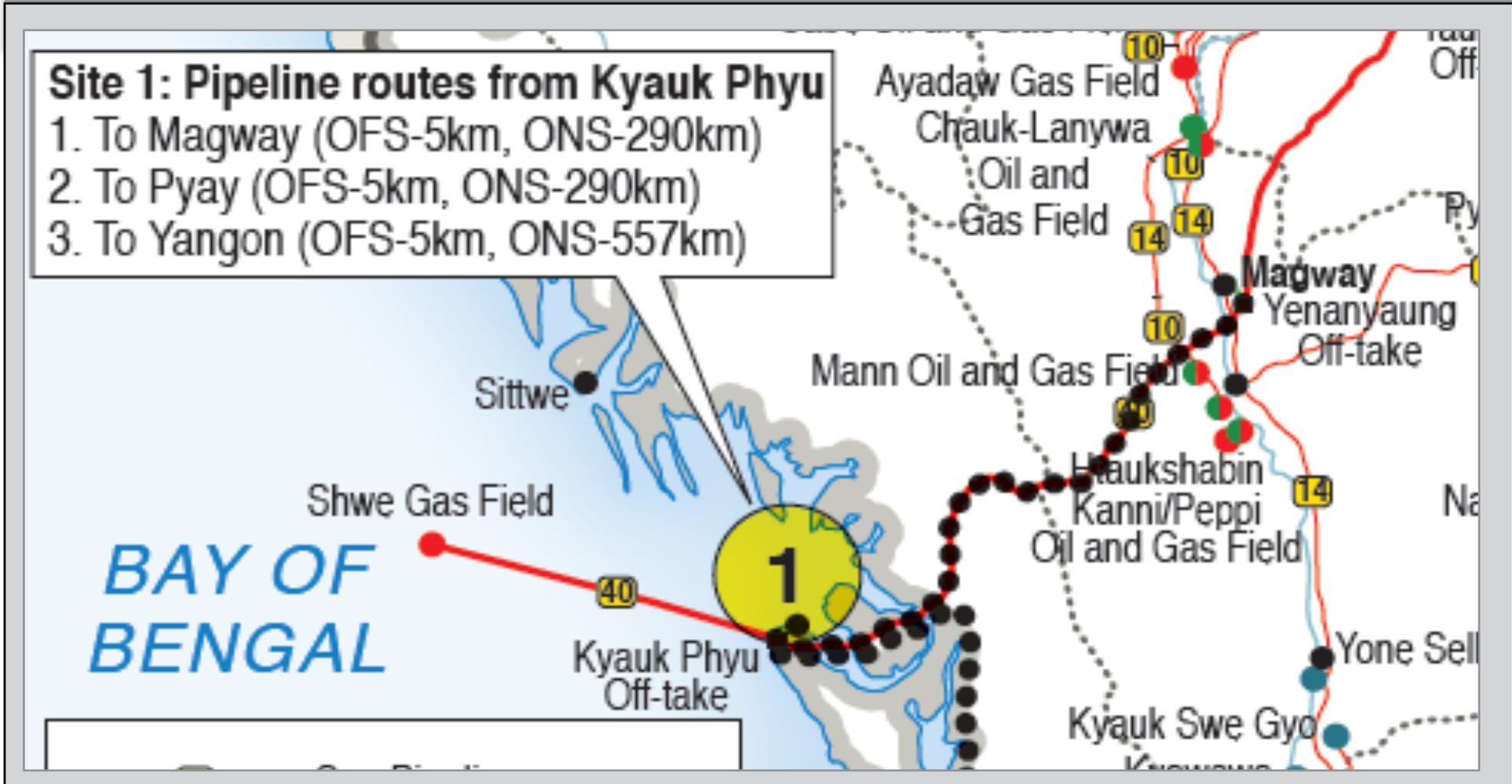


Pipeline & terminal protests



Site 1: Pipelines – re-use

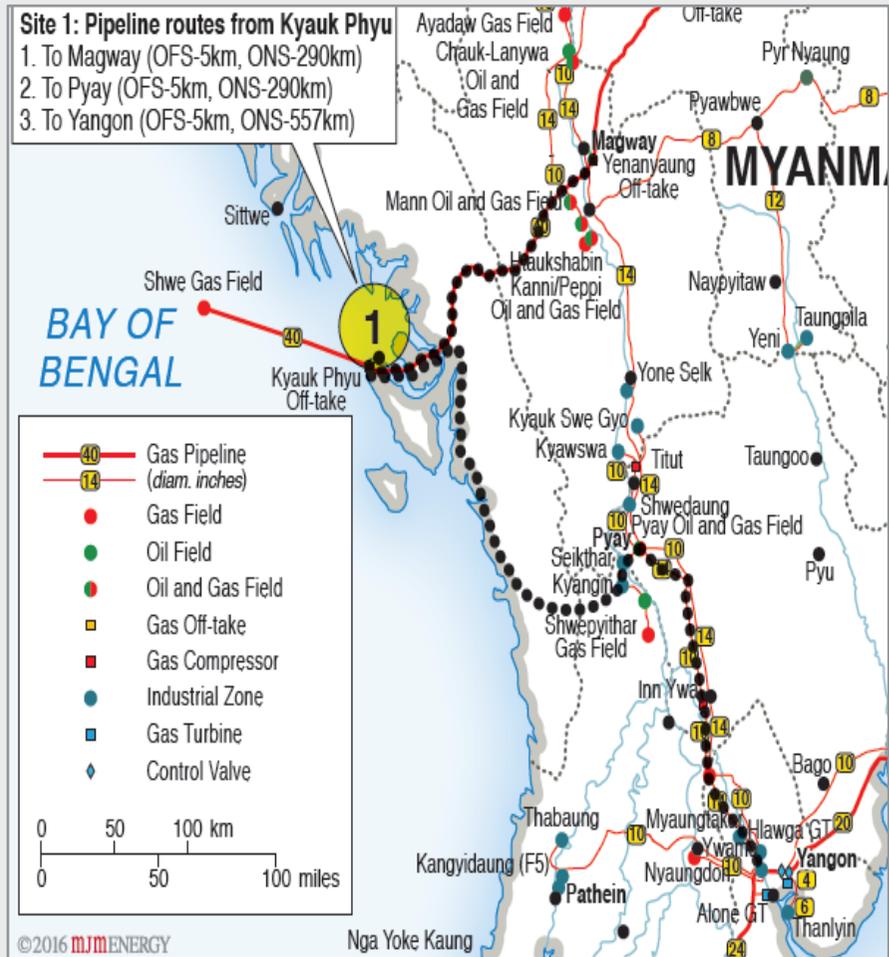
Negotiate access to the existing Shwe pipeline to Magway



Site 1: Pipelines - new

- Option 1 – New 290km pipeline to Magway in the ROW of the Shwe pipeline.
- Option 2 – A new 290 km pipe to Pyay following the route of the current road.
- Option 3 – A new ROW in the road to Pyay which then follows the 14" pipeline to Yangon, total distance estimated at around 557km.
- All pipelines are 30 inch to avoid need for compressor stations.

Pipeline routes



Site 1: Local Infrastructure

- Suitable tugs are available at the oil terminal – availability uncertain.
- Unable to provide essential business services for foreign investors.
- Little industry and low skilled workforce.
- Health care underfunded and poorly equipped.
- No significant port infrastructure.
- Poor road connections.

Tug Infrastructure



5 tugs at oil terminal

Site 1: Technology selection

- Any near shore solution based on a jetty.
- Mid water depth option is possible but as significant additional dredging would be required there is no advantage.
- A Jetty moored FSRU is the most flexible option with a short delivery timescale.
- An onshore terminal should only be considered if LNG supply is for longer than 10 years or high levels of security of supply are required.

Jetty moored FSRU



FSRU Independence in Lithuania

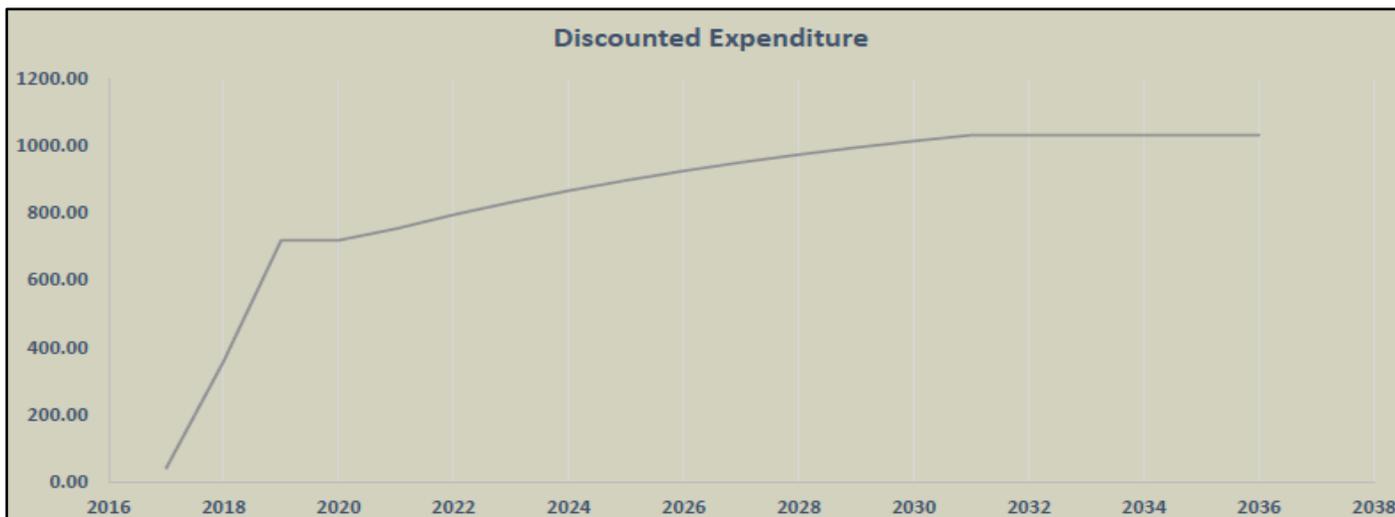
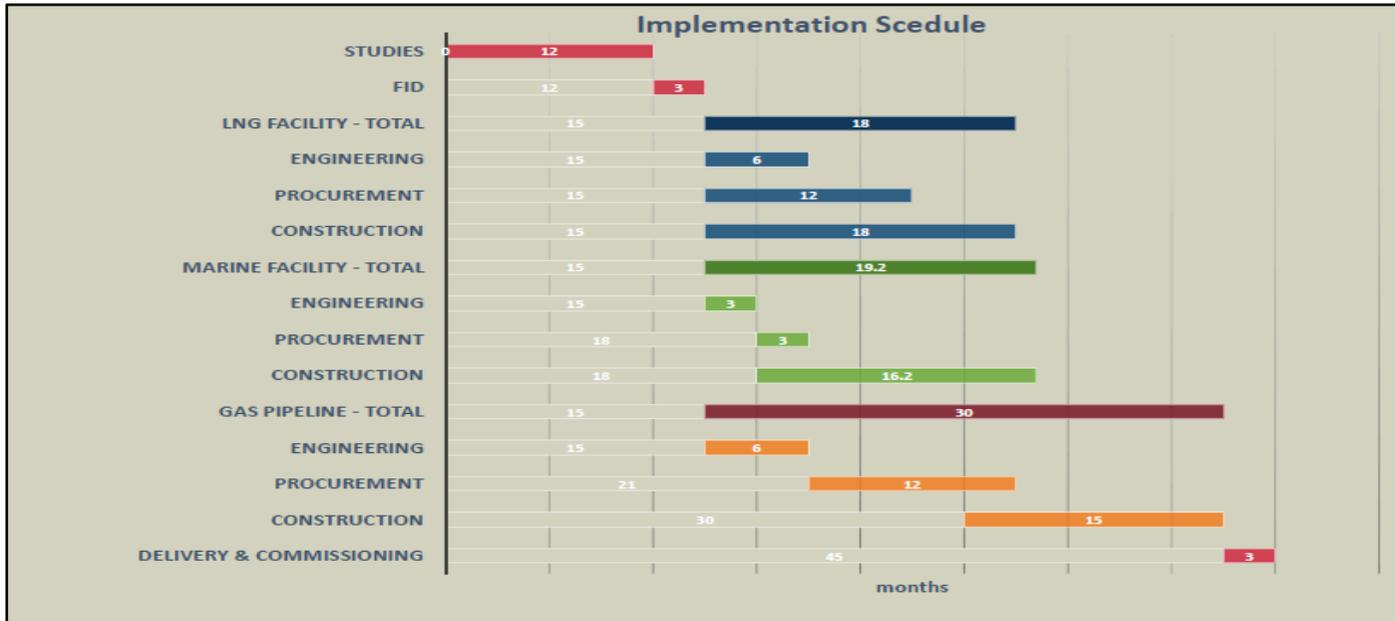
Site 1: Results – Site 1: Kyauk Phyu Traffic light scoring

		Site 1: Kyauk Phyu													
		Site 1 A Maday Island						Site 1 B Kyauk Phyu							
		Onshore terminal	FSRU on Jetty	Midwater FSRU	Deepwater FSRU	FSU on Jetty	NGRV in Deepwater	GBS	Onshore terminal	FSRU on Jetty	Midwater FSRU	Deepwater FSRU	FSU on Jetty	NGRV in Deepwater	GBS
GETTING LNG TO THE TERMINAL															
1	How much dredging is required to create a channel to the terminal?	Yellow	Yellow	Orange	Grey	Yellow	Grey	Yellow	Yellow	Orange	Grey	Yellow	Grey	Yellow	Grey
2	What Jetty length is required to be able to moor a near shore FSRU/LNG Carrier?	Green	Green	Grey	Green	Grey	Green	Green	Grey	Green	Grey	Green	Grey	Green	Grey
OR	What Subsea pipeline length is required to connect a midwater or deepwater FSRU or LNGRV?	Grey	Grey	Green	Grey	Green	Grey	Green	Grey	Green	Grey	Green	Grey	Green	Grey
3	How much marine traffic is currently being experienced?	Yellow	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Grey
4	Are there local visibility limitations?	Yellow	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Grey
5	Are there any other factors that limit the site?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey
STORING LNG															
1	What is the wave environment like?	Green	Green	Green	Grey	Green	Grey	Green	Green	Green	Grey	Green	Grey	Green	Grey
2	How variable is the wind/wave environment?	Green	Green	Green	Grey	Green	Grey	Green	Green	Green	Grey	Green	Grey	Green	Grey
3	Might the LNG facility be impacted by extreme weather?	Red	Red	Red	Grey	Red	Grey	Red	Red	Red	Grey	Red	Grey	Red	Grey
4	Will the site cause any destruction or exclusion to environmentally sensitive areas?	Yellow	Yellow	Green	Grey	Yellow	Grey	Yellow	Yellow	Green	Grey	Yellow	Grey	Yellow	Grey
5	Will the site cause any destruction or exclusion to culturally and historically sensitive areas?	Green	Green	Green	Grey	Green	Grey	Green	Yellow	Green	Grey	Yellow	Grey	Yellow	Grey
6	Will the site development and operation impact the local community in any detrimental way?	Yellow	Yellow	Green	Grey	Yellow	Grey	Yellow	Orange	Orange	Grey	Yellow	Grey	Orange	Grey
7	Will the site development and operation increase the risk of harm/fatality to the local community?	Yellow	Yellow	Green	Grey	Yellow	Grey	Yellow	Orange	Orange	Grey	Yellow	Grey	Orange	Grey
8	Are there risks to the LNG facility from geological events?	Red	Red	Orange	Grey	Red	Grey	Red	Red	Red	Grey	Red	Grey	Red	Grey
GETTING GAS TO MARKET															
1	Can LNG be vaporised in sufficient volume and in an environmentally acceptable way?	Green	Green	Green	Grey	Green	Grey	Green	Green	Green	Grey	Green	Grey	Green	Grey
2	What is the onshore pipeline length?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey
3	What is the difficulty in laying the onshore pipeline?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey
4	What is the offshore pipeline length?	Green	Green	Green	Grey	Green	Grey	Green	Green	Green	Grey	Green	Grey	Green	Grey
5	What is the difficulty in laying the offshore pipeline?	Green	Green	Green	Grey	Green	Grey	Green	Green	Green	Grey	Green	Grey	Green	Grey
LOCAL INFRASTRUCTURE															
1	Is there sufficient towage available to berth the LNG carrier?	Green	Green	Green	Grey	Green	Grey	Green	Green	Green	Grey	Green	Grey	Green	Grey
2	Is there currently any port rules and infrastructure appropriate to hydrocarbon importation at the proposed LNG	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey
3	Is there sufficient infrastructure to accommodate workers and their families, expatriates and vendor personnel?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey
4	Is there emergency response and Health care capability?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey
5	Education and Skills?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey
6	Is there access to a major port with connecting roads?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey
7	Is there access to an international airport with road/rail links?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey
8	How adequate is the marine infrastructure?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey

Site 1: Results – Summary data inputs for the analysis for Site 1A2

PHYSICAL PARAMETERS:		Data
LNG facility size		170,000 m ³ stored with 500 mmscf/d vaporiser capacity
LNG facility type		FSRU
Location		Nearshore
Ownership		Lease
geology		<0.4 g acceleration
Jetty length		200 m
Breakwater		Not required
Dredging		2,000,000 m ³
Gas pipeline		5 km of 30 inch offshore + 557 km of 30 inch onshore
Design LNG ship		163,000 m ³
FINANCIAL AND ECONOMIC PARAMETERS:		Data
Project start year		2017
LNG import term		10 years
Discount rate		10%
Lease rate		140,000 US\$/day
Fuel oil cost		470 US\$/ton 380 cs Singapore
Electricity cost		0.05 US\$/kWh (70 kyats/kWh)
Tug cost		US\$ 15,000/day each (no mobilisation costs)
CAPITAL COSTS: Description of key areas		Value
FSRU		0 US\$ million (lease)
Jetty		138 US\$ million
Dredging		10 US\$ million
Gas pipeline		677.6 US\$ million
Local infrastructure		0 US\$ million
TOTAL		826.03 US\$ million
Note 1 : No BOT/BOOT purchase payment was assumed at the end of the contract life.		
OPERATING COSTS: Description of key areas		Operating costs
FSRU lease		51 US\$ million pa
Fixed costs	Labour	3 US\$ million pa
	Insurance	2 US\$ million pa
	Inspection and maintenance	2 US\$ million pa
	Supporting infrastructure	0 US\$ million pa
Variable costs	Fuel oil	6.48 US\$ million pa
	Electricity	0 US\$ million pa
	Towage	1.6 US\$ million pa
TOTAL		66.20 US\$ million pa
Notes		
1. The above calculation is based on a 557km connecting pipeline to Yangon. If Site 1A2 was to opt for the shorter 290km onshore connection to either Pyay or Magway the CAPEX costs would be reduced by \$320.4 million, with an equivalent reduction in the DCF figure.		

Site 1: Results – Implementation schedule and cash flow



Site 1: Results Summary

Site 1A2

- Schedule to market: 48 months
- Capital Cost: 826 US\$ million
- Operating cost: 66 US\$ million/year
- Discounted Expenditure: 1032 US\$ million

- Calculation based on 557 km pipeline to Yangon

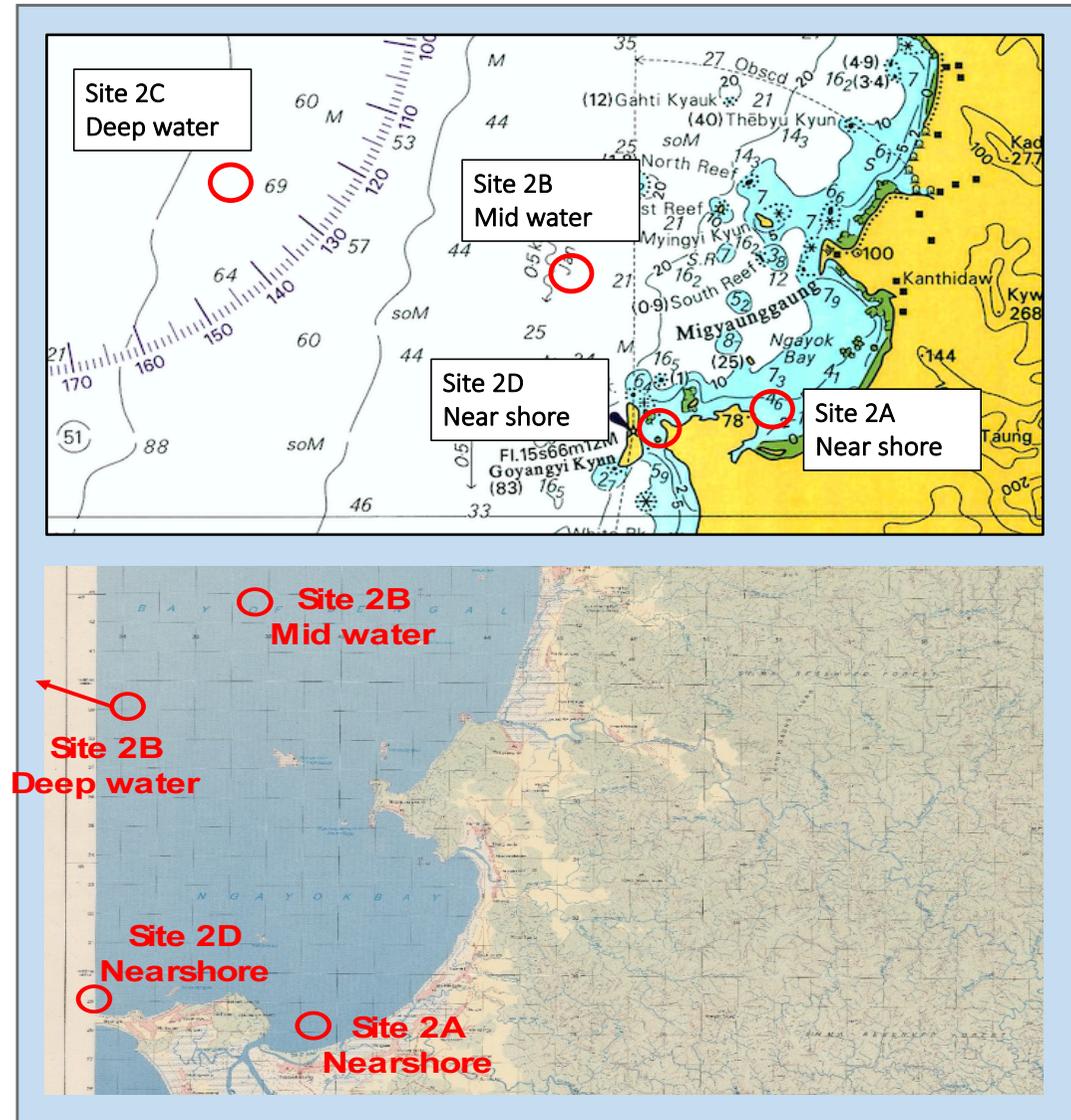
Section 5: Site 2 Nga Yoke Kaung

Site 2: Overview

Site Locations

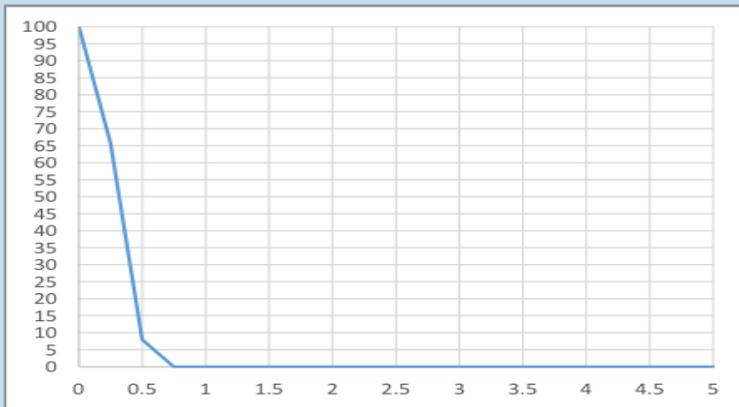
Three sites considered as follows:

- Site 2A near the shore sheltered behind the headland to the south of Ngayok Bay.
- Site 2B in 20 m of water beyond the islands to the north end of Ngayok Bay about 10 – 15 km offshore.
- Site 2C in 80 m of water 30 – 40 km offshore of Ngayok Bay.
- Site 2D near the shore at the southern headland about 1.0 km off shore

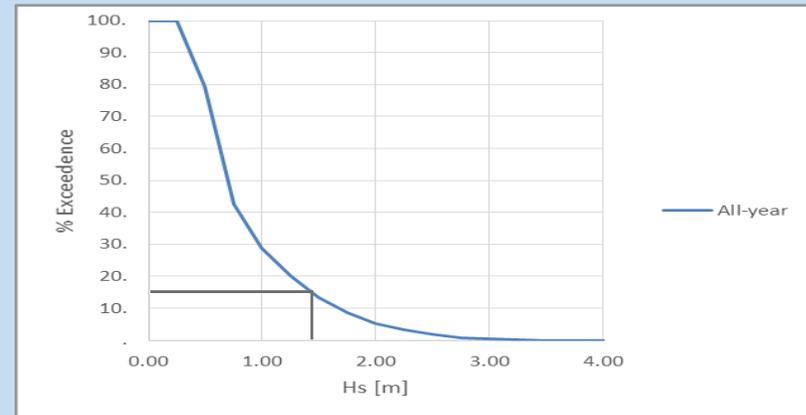


Site 2: Metocean analysis

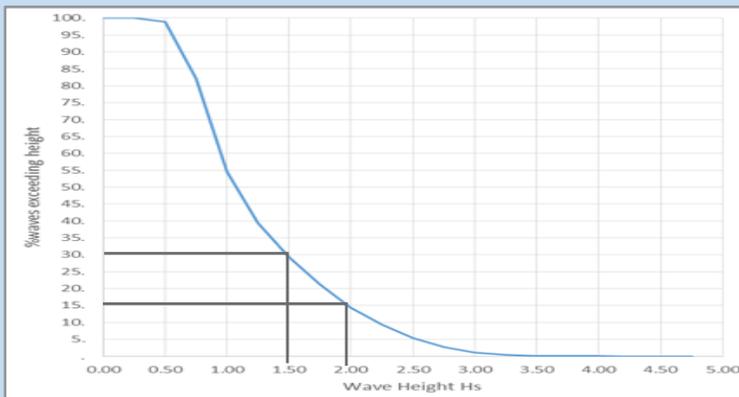
Wave height exceedance curves (Pilot station) Site 2A



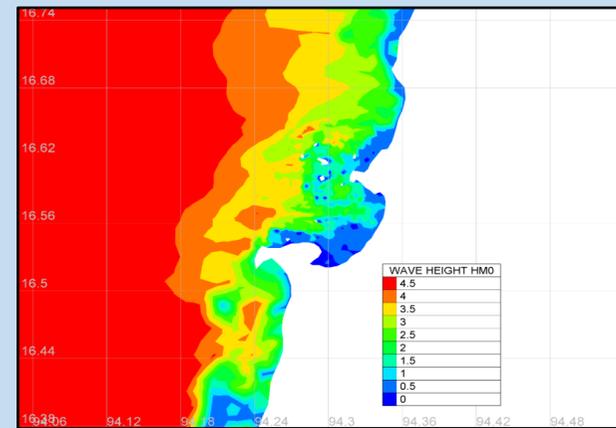
Wave height exceedance curves (Pilot station) Sites 2D



Wave height exceedance curves (Pilot station) Sites 2B and 2C



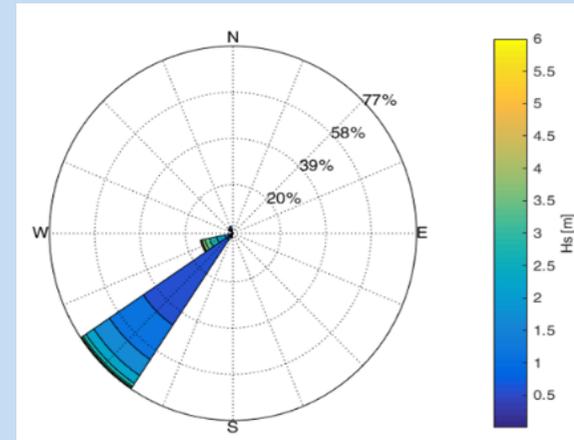
Non Cyclonic Storm



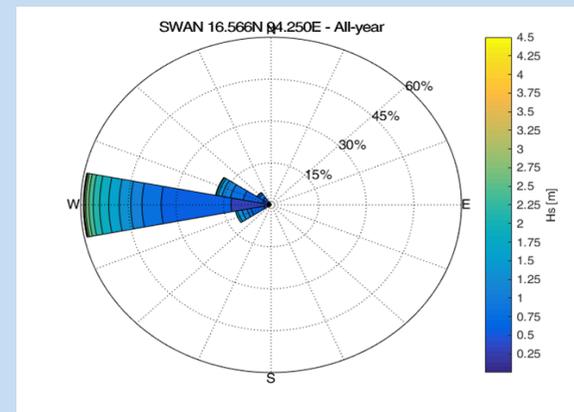
Site 2: Metocean analysis

- All four sites are exposed to SW winds and monsoon.
- Sites 2A and 2D have some shelter behind the headland.
- Non cyclonic storms will impact operations at Sites 2B and 2C.
- Winds are insufficient to challenge LNG carrier mooring guidelines.

Wave & wind rosettes 2A,B,C



Wave & wind rosettes 2D

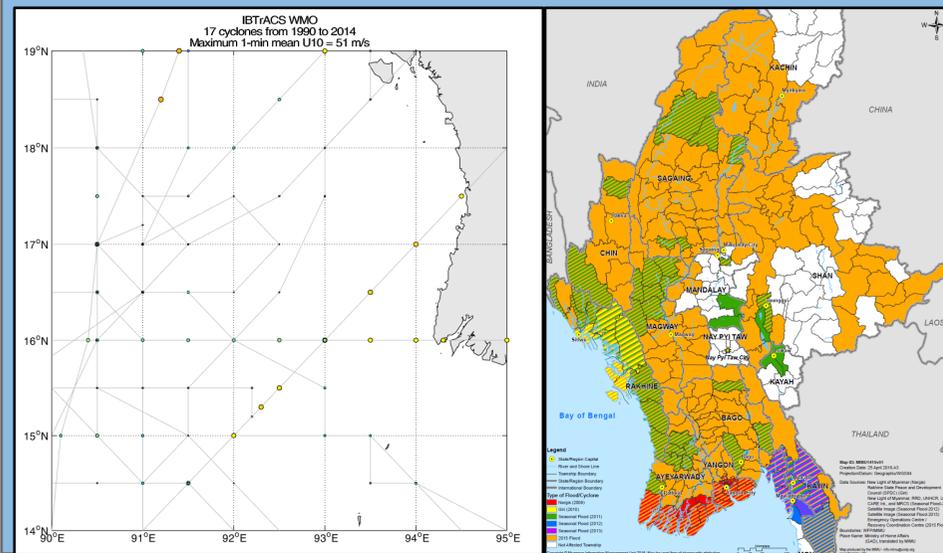


Site 2: Weather & Geology

Weather

- Cyclones are prevalent in Northern Myanmar and should be expected.
- Flooding has occurred twice since 2010.

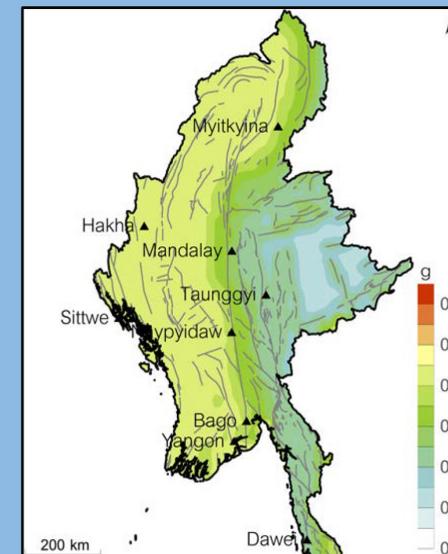
Cyclone tracks & flooding events



Geology

- Magnitude 3 and 4 earthquakes have occurred nearby.
- High peak ground accelerations are anticipated (0.4 – 0.45g).

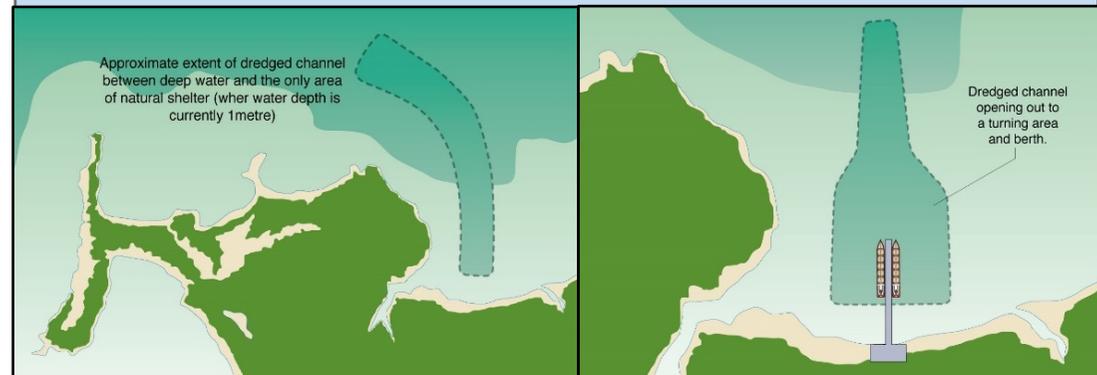
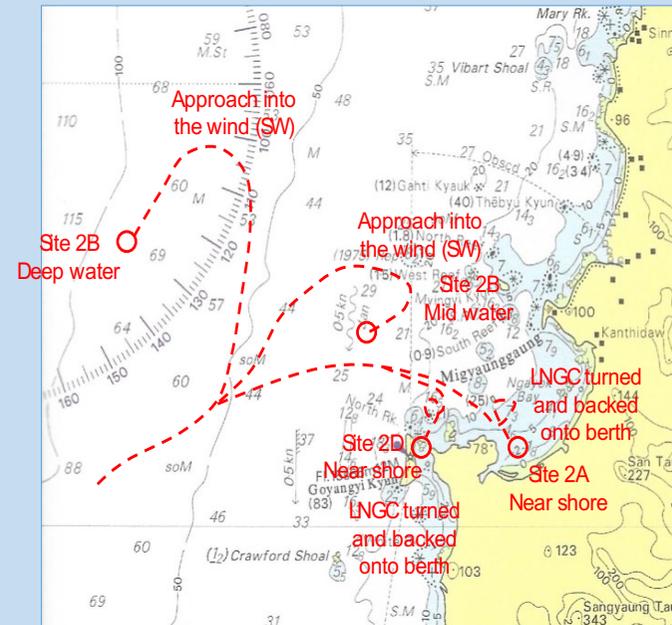
Peak ground accelerations



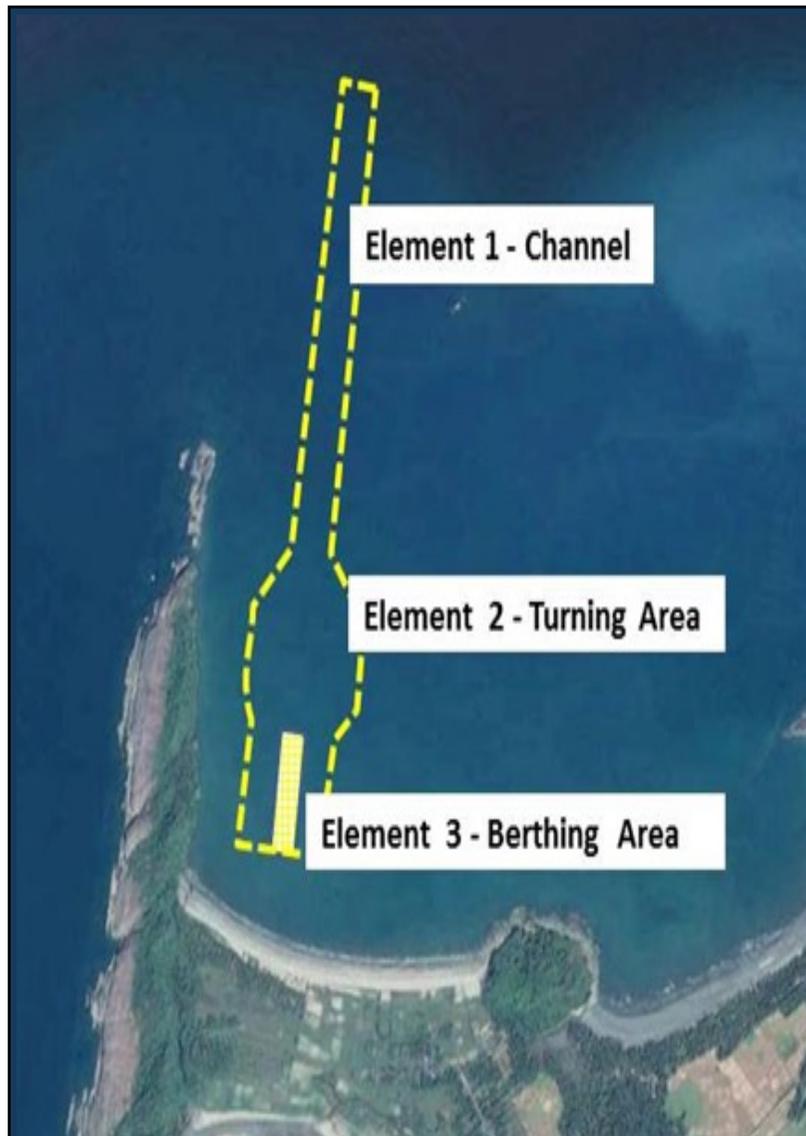
Site 2: Navigational assessment

- Site 2A is in very shallow water (2 m) and needs extensive dredging to 14 m for an LNG carrier to berth on a short jetty.
- Reducing the dredging by extending the jetty reduces and then eliminates the wave protection provided by the headland.
- Offshore sites 2B and 2C are in deep water and present no navigational issues.

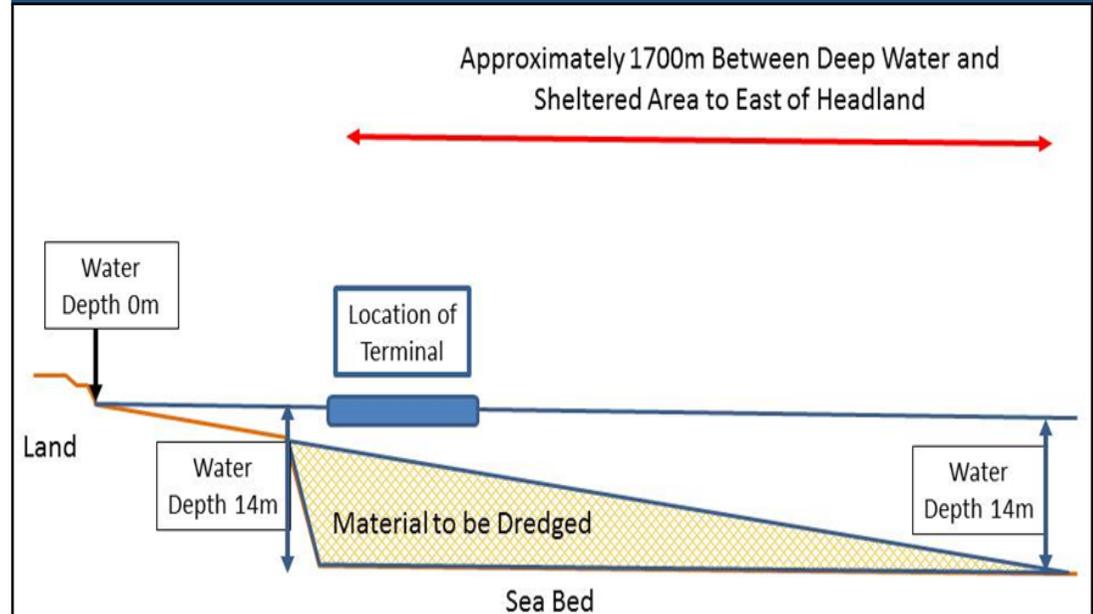
Navigating to Site 2



Site 2: Navigational assessment



Navigating to Site 2D

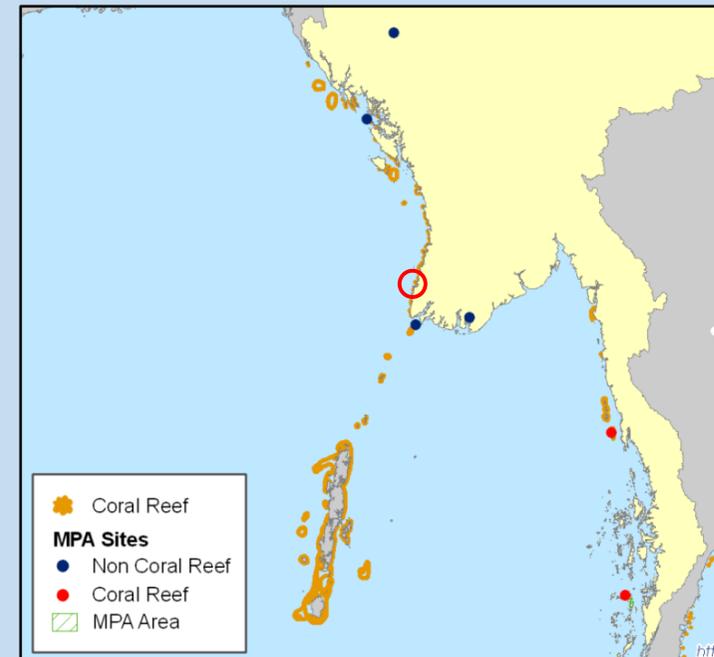


Element	Area To Be Dredged (Description)	Area To Be Dredged (Area in m ²)	Current Estimated Mean Water Depth (m)	Required Water Depth (m)	Depth to be Dredged (m)	Volume of Dredged Material (m ³)
1 - Channel	1500m channel x 217m wide	325,500	9.0	14.0	5.0	1,627,500
2 - Turning Circle	285m diameter circle	255,278	3.0	14.0	11.0	2,808,058
3 - Berthing Area	(4 x Beam) x (1.5 x LOA)	74,214	3.0	14.0	11.0	816,354
TOTAL ESTIMATE OF DREDGED MATERIAL in CUBIC METRES						5,251,912

Site 2: Environmental, Social & Cultural Impacts

- Coral and mangrove are definitely present. Seagrass and turtles may be present.
- Local tourist industry advertises snorkelling and diving.
- Beach resorts in the general area.
- Proposed coal fired power plant in the bay rejected after local protests.
- Dredging would damage coral as would cold water/biocide return from vaporisation.
- Four local villages potentially impact by near shore terminal.

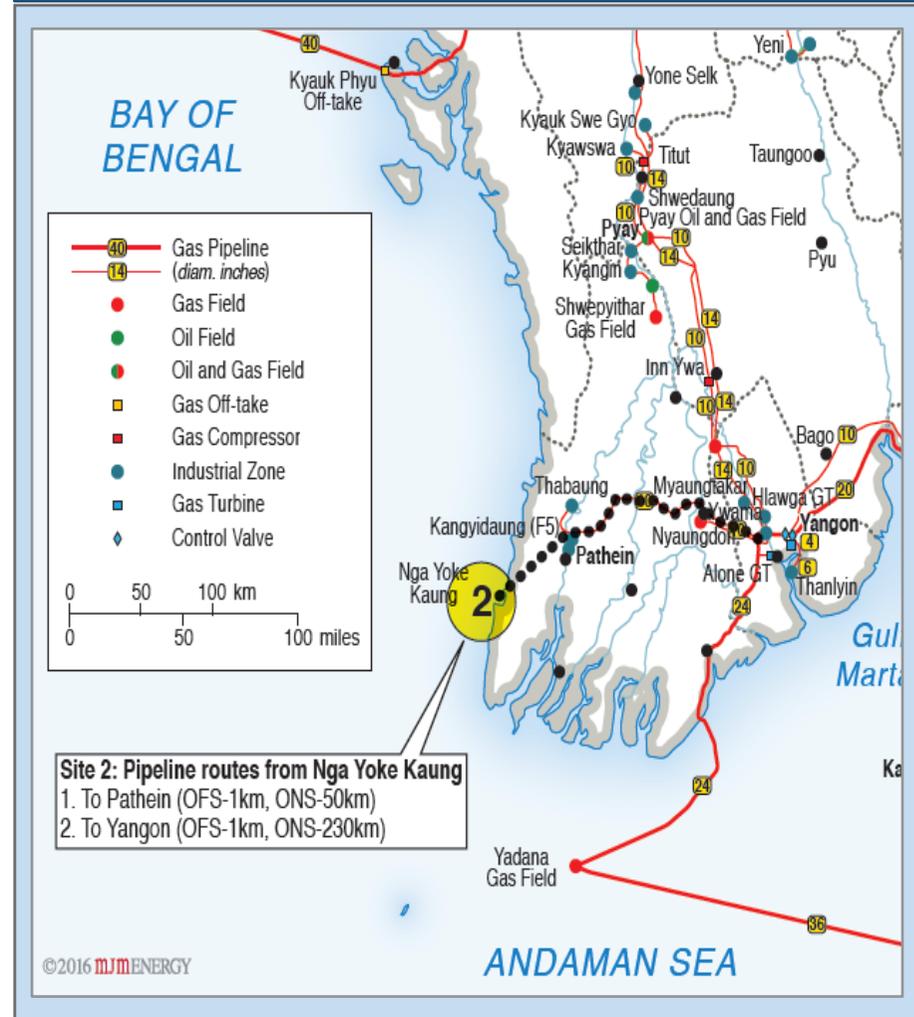
Environmental impact



Site 2: Pipelines

- Background – the existing 10 inch pipeline to Yangon via Pathein to Thabaung is too small and low pressure for new flows.
- Option 1 - Lay new 30 inch 50km pipeline in a new ROW to Pathein.
- Option 2 - Lay a new 30 inch 230km pipeline via Pathein to Yangon
- No reinforcement costs required unless gas is required for proposed power plant at Shwedaung.

Pipeline route



Site 2: Local infrastructure

- No tugs, nearest tugs at Shwe oil terminal.
- No coastal port or port authority.
- Pathein is only able to provide the most basic business services.
- Little industry and relatively low skill workforce.
- Technical and IT universities in Pathein should be able to provide some skills .
- Health care present.
- Large port at Pathein for river traffic but with no significant port infrastructure.
- Poor road connections.

Pathein



Site 2: Technology selection

- Near shore site 2A is too difficult environmentally.
- Mid (Site 2B) or deep water (Site 2C) options possible but challenging.
- Little difference in wave environment so deep water, buoy moored, FSRU is preferred as more robust in extreme weather.
- Near shore site 2D is environmentally difficult.
- Site 2D has all the issues as site 2A but at smaller scale.
- Challenging but possible.

Technology selection

Challenging!

Site 2C Deep water



Site 2D Protected by headland



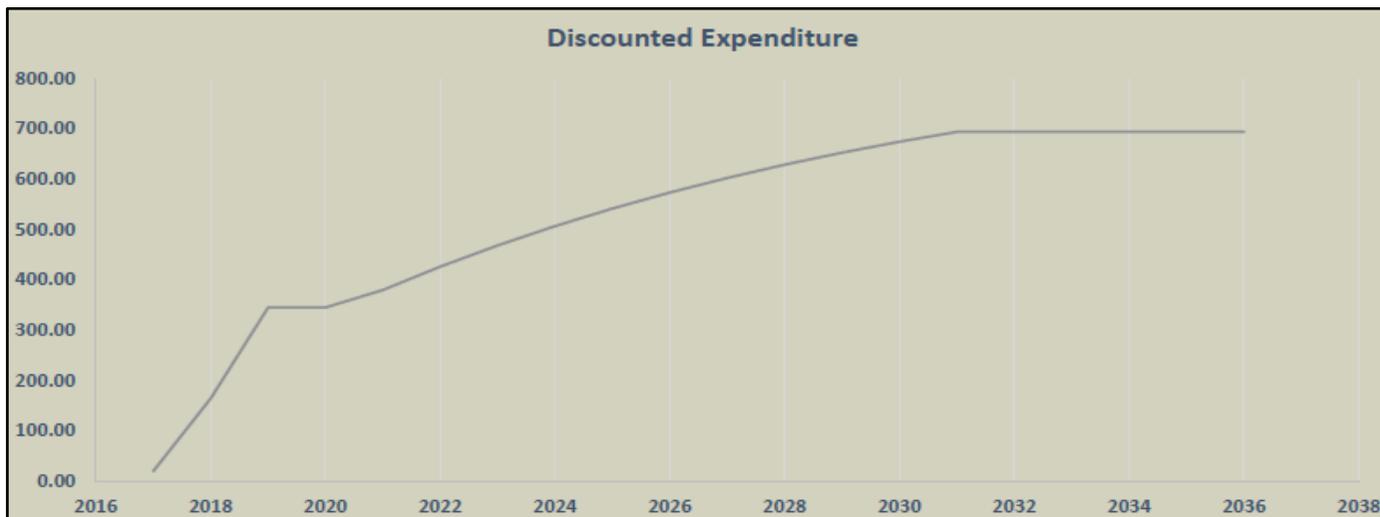
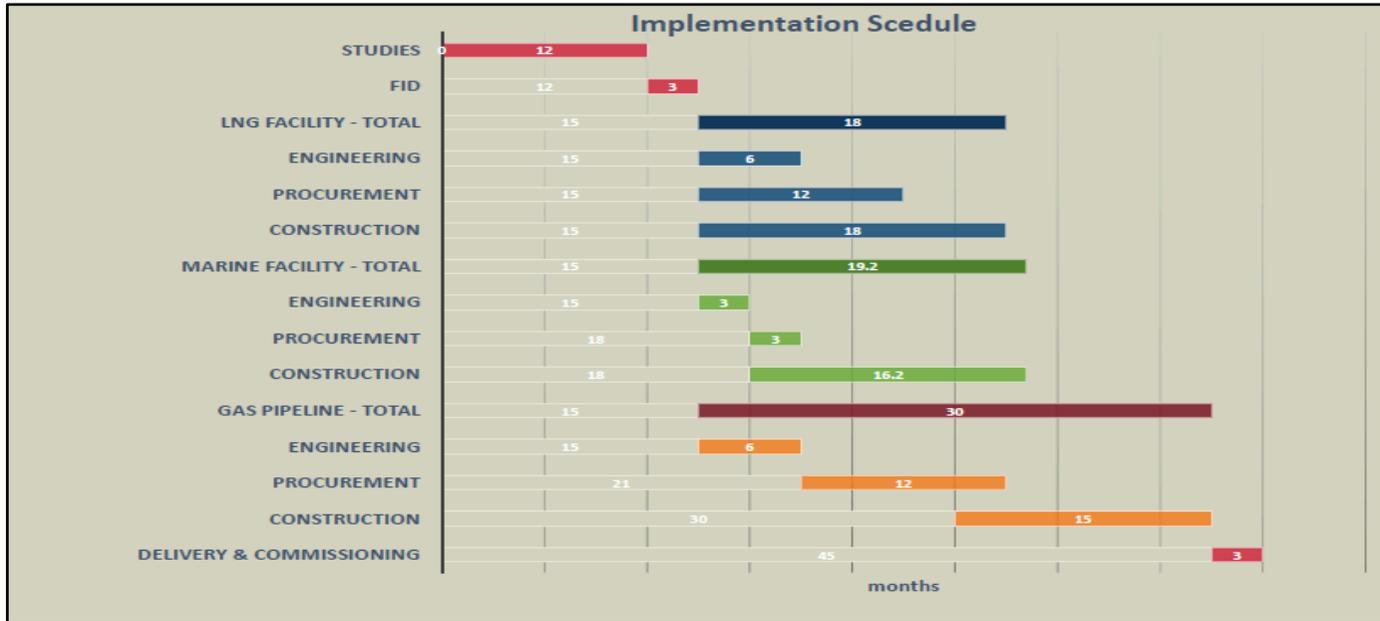
Site 2: Results –Nga Yoke Kuang traffic light scoring for 2A, B and C

		Nearshore Site 2A						Offshore Sites 2B & 2C							
		Onshore	FSRU on	Midwater	Deepwater	FSU on	NGRV in	GBS	Onshore	FSRU on	Midwater	Deepwater	FSU on	NGRV in	GBS
		terminal	Jetty	FSRU	FSRU	Jetty	Deepwater		terminal	Jetty	FSRU	FSRU	Jetty	Deepwater	
GETTING LNG TO THE TERMINAL															
1	How much dredging is required to create a channel to the terminal?	Red	Red	Grey	Grey	Red	Grey	Grey	Green	Green	Green	Green	Green	Green	Green
2	What Jetty length is required to be able to moor a near shore FSRU/LNG Carrier?	Yellow	Yellow	Grey	Grey	Yellow	Grey	Grey	Red	Red	Grey	Grey	Red	Grey	Green
OR	What Subsea pipeline length is required to connect a midwater or deepwater FSRU or LNGRV?	Grey	Grey	Not Possible	Grey	Not Possible	Grey	Grey	Grey	Grey	Green	Green	Grey	Green	Green
3	How much marine traffic is currently being experienced?	Green	Green	Grey	Grey	Green	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
4	Are there local visibility limitations?	Yellow	Yellow	Grey	Grey	Yellow	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
5	Are there any other factors that limit the site?	Yellow	Yellow	Grey	Grey	Yellow	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
STORING LNG															
1	What is the wave environment like?	Orange	Orange	Grey	Grey	Orange	Grey	Grey	Red	Red	Red	Red	Red	Red	Red
2	How variable is the wind/wave environment?	Orange	Orange	Grey	Grey	Orange	Grey	Grey	Red	Red	Red	Red	Red	Red	Red
3	Might the LNG facility be impacted by extreme weather?	Orange	Orange	Not Possible	Grey	Not Possible	Grey	Grey	Orange	Orange	Orange	Orange	Orange	Orange	Orange
4	Will the site cause any destruction or exclusion to environmentally sensitive areas?	Orange	Orange	Grey	Grey	Orange	Grey	Grey	Orange	Orange	Yellow	Yellow	Orange	Yellow	Orange
5	Will the site cause any destruction or exclusion to culturally and historically sensitive areas?	Yellow	Yellow	Grey	Grey	Yellow	Grey	Grey	Yellow	Yellow	Green	Green	Yellow	Green	Green
6	Will the site development and operation impact the local community in any detrimental way?	Orange	Orange	Grey	Grey	Orange	Grey	Grey	Orange	Orange	Yellow	Yellow	Orange	Yellow	Orange
7	Will the site development and operation increase the risk of harm/fatality to the local community?	Yellow	Yellow	Grey	Grey	Yellow	Grey	Grey	Yellow	Yellow	Green	Green	Yellow	Green	Yellow
8	Are there risks to the LNG facility from geological events?	Red	Red	Grey	Grey	Red	Grey	Grey	Red	Red	Orange	Yellow	Red	Yellow	Red
GETTING GAS TO MARKET															
1	Can LNG be vaporised in sufficient volume and in an environmentally acceptable way?	Yellow	Yellow	Grey	Grey	Yellow	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2	What is the onshore pipeline length?	Yellow	Yellow	Not Possible	Grey	Not Possible	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
3	What is the difficulty in laying the onshore pipeline?	Yellow	Yellow	Grey	Grey	Yellow	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
4	What is the offshore pipeline length?	Green	Green	Grey	Grey	Green	Grey	Grey	Green	Green	Green	Green	Green	Green	Green
5	What is the difficulty in laying the offshore pipeline?	Yellow	Yellow	Grey	Grey	Yellow	Grey	Grey	Yellow	Yellow	Orange	Orange	Yellow	Orange	Orange
LOCAL INFRASTRUCTURE															
1	Is there sufficient towage available to berth the LNG carrier?	Red	Red	Grey	Grey	Red	Grey	Grey	Red	Red	Red	Red	Red	Red	Red
2	Is there currently any port rules and infrastructure appropriate to hydrocarbon importation at the proposed LNG site?	Red	Red	Grey	Grey	Red	Grey	Grey	Red	Red	Red	Red	Red	Red	Red
3	Is there sufficient infrastructure to accommodate workers and their families, expatriates and vendor personnel?	Red	Red	Grey	Grey	Red	Grey	Grey	Red	Red	Red	Red	Red	Red	Red
4	Is there emergency response and Health care capability?	Yellow	Yellow	Not Possible	Grey	Not Possible	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
5	Education and Skills?	Yellow	Yellow	Grey	Grey	Yellow	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
6	Is there access to a major port with connecting roads?	Red	Red	Grey	Grey	Red	Grey	Grey	Red	Red	Red	Red	Red	Red	Red
7	Is there access to an international airport with road/rail links?	Orange	Orange	Grey	Grey	Orange	Grey	Grey	Orange	Orange	Orange	Orange	Orange	Orange	Orange
8	How adequate is the marine infrastructure?	Red	Red	Grey	Grey	Red	Grey	Grey	Red	Red	Red	Red	Red	Red	Red

Site 2: Results –Summary data inputs for the analysis for Site 2D

PHYSICAL PARAMETERS:		Data
LNG facility size		170,000 m ³ stored with 500 mmscfd vaporiser capacity
LNG facility type		FSRU
Location		Nearshore
Ownership		Lease
geology		<0.4 g acceleration
Jetty length		0 m
Breakwater		Not required
Dredging		5,200,000 m ³
Gas pipeline		1 km of 30 inch offshore + 230 km of 30 inch onshore
Design LNG ship		163,000 m ³
FINANCIAL AND ECONOMIC PARAMETERS:		Data
Project start year		2017
LNG import term		10 years
Discount rate		10%
Lease rate		140,000 US\$/day
Fuel oil cost		470 US\$/ton 380 cs Singapore
Electricity cost		0.05 US\$/kWh (70 kyats/kWh)
Tug cost		US\$ 15,000/day each (4 days mobilisation))
CAPITAL COSTS: Description of key areas		Value
FSRU		0 US\$ million (lease)
Jetty		46 US\$ million
Dredging		26 US\$ million
Gas pipeline		278 US\$ million
Local infrastructure		0 US\$ million
TOTAL		350 US\$ million
Note 1 : No BOT/BOOT purchase payment was assumed at the end of the contract life.		
OPERATING COSTS: Description of key areas		Operating costs
FSRU lease		51 US\$ million pa
Fixed costs	Labour	3 US\$ million pa
	Insurance	2 US\$ million pa
	Inspection and maintenance	2 US\$ million pa
	Supporting infrastructure	2.2 US\$ million pa
Variable costs	Fuel oil	6.48 US\$ million pa
	Electricity	0 US\$ million pa
	Towage	14.6 US\$ million pa
TOTAL		81.4 US\$ million pa
Notes		
1. The above calculation is based on a 230km connecting pipeline to Yangon. If Site 2D was to opt for the shorter 50km onshore connection to Pathein the CAPEX costs would be reduced by \$204 million, with an equivalent reduction in the DCF figure.		

Site 2: Results – Implementation schedule and cash flow



Site 2: Results Summary

Site 2D

- Schedule to market: 48 months
 - Capital Cost: 350 US\$ million
 - Operating cost: 80 US\$ million/year
 - Discounted Expenditure: 682 US\$ million
-
- 230 km pipeline to Yangon, a shorter pipeline to Pathein may be possible

Site 2C

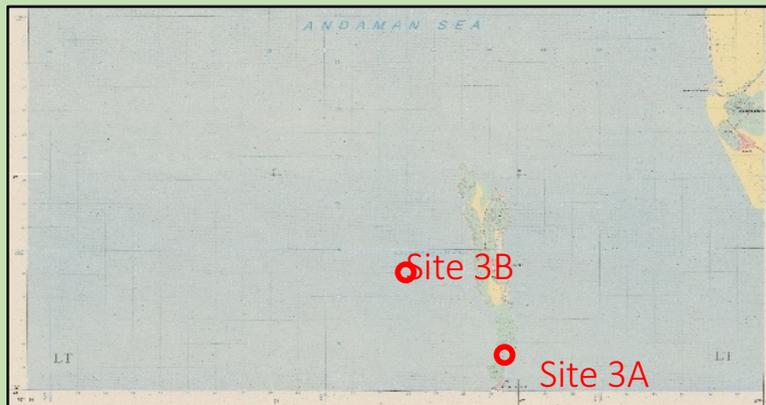
- Not developed – considered too challenging

Section 6: Site 3 Kalegauk Island

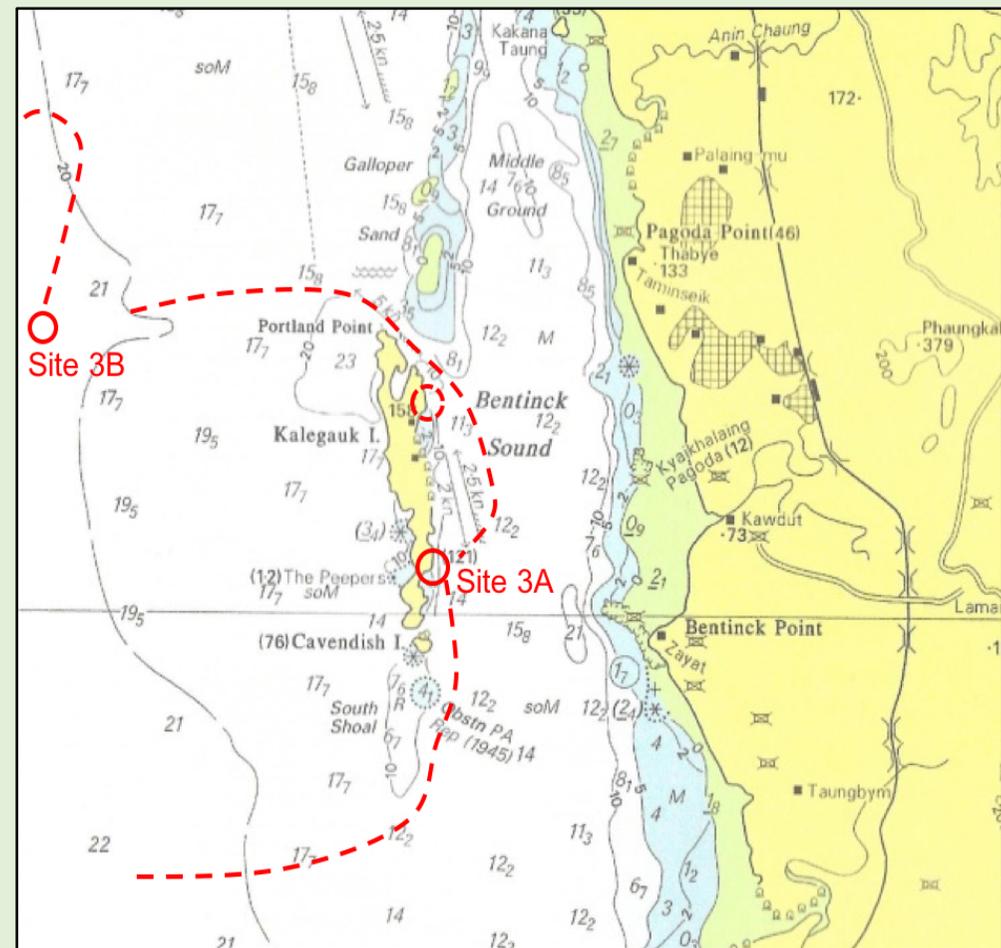
Site 3: Overview

Two sites considered:

- Site 3A in Bentinck Sound to the east of Kalgauk Island. (NB: Two sites are possible but proximity to local populations favours the southern site – the northern site is not considered further.)
- Site 3B is located offshore in 20 m of water in the Andaman Sea to the northwest of Kalgauk Island.



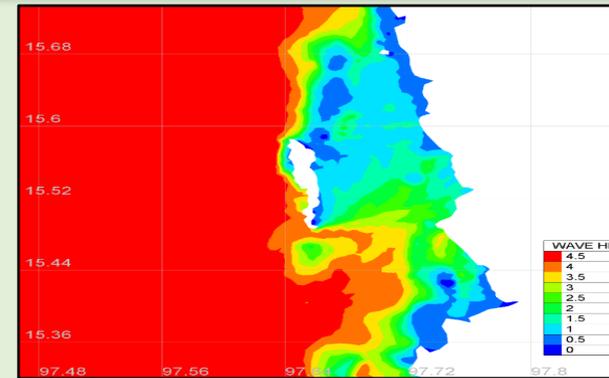
Site Locations



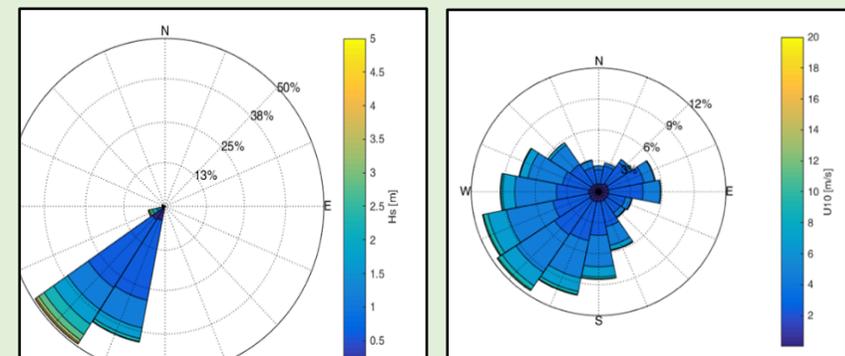
Site 3: Metocean Analysis

- Both sites are relatively sheltered from SW winds and monsoon by the Andaman Islands.
- Site 3A has additional protection from Kalgauk Island.
- Non cyclonic storms will impact operations at Sites 3B but are infrequent.
- Winds are insufficient to challenge LNG carrier mooring guidelines.

Non cyclonic storm

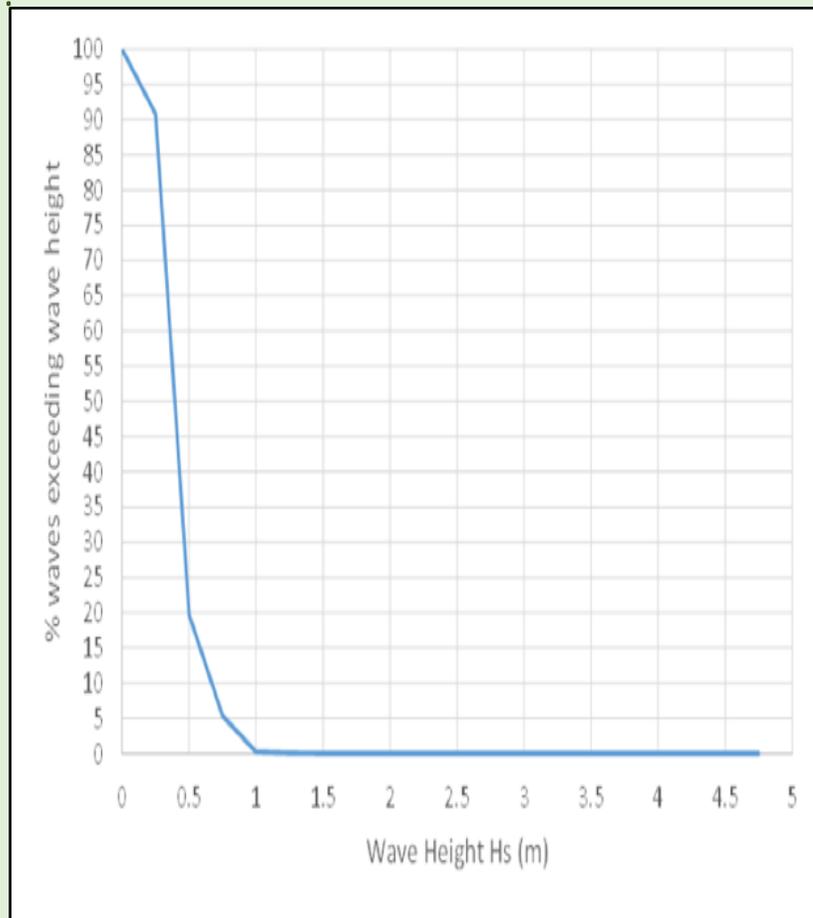


wind & wave rosettes

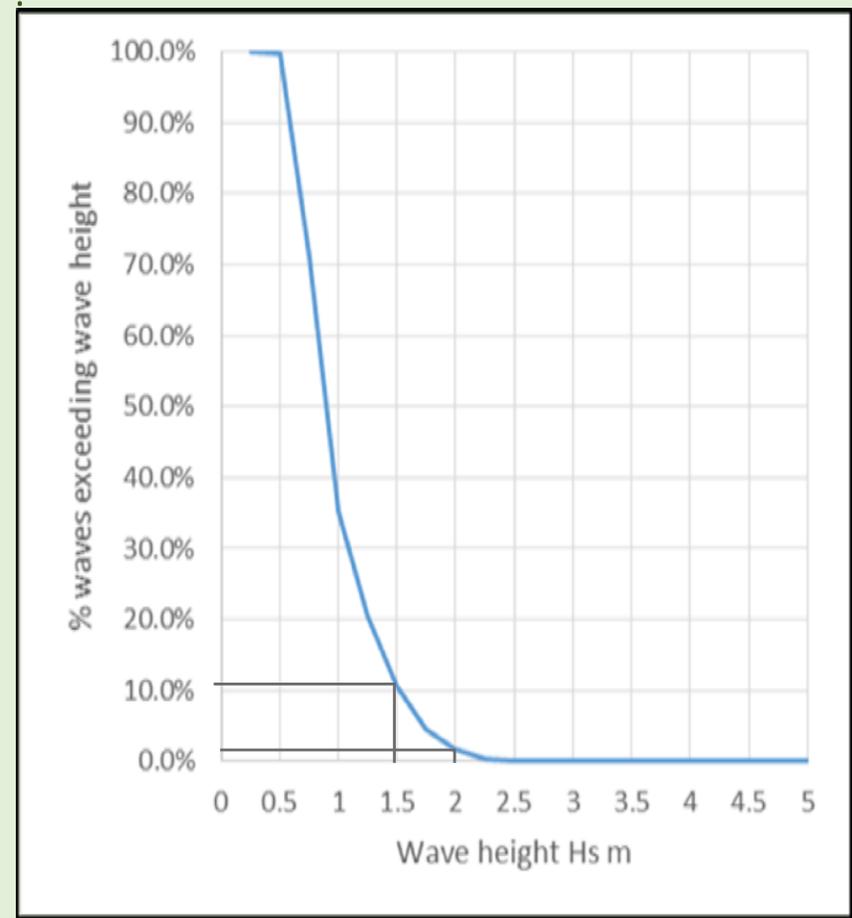


Site 3: Metocean Analysis

Wave height exceedance curve
at berth Site 3A



Wave height exceedance curve
at pilot station Site 3B

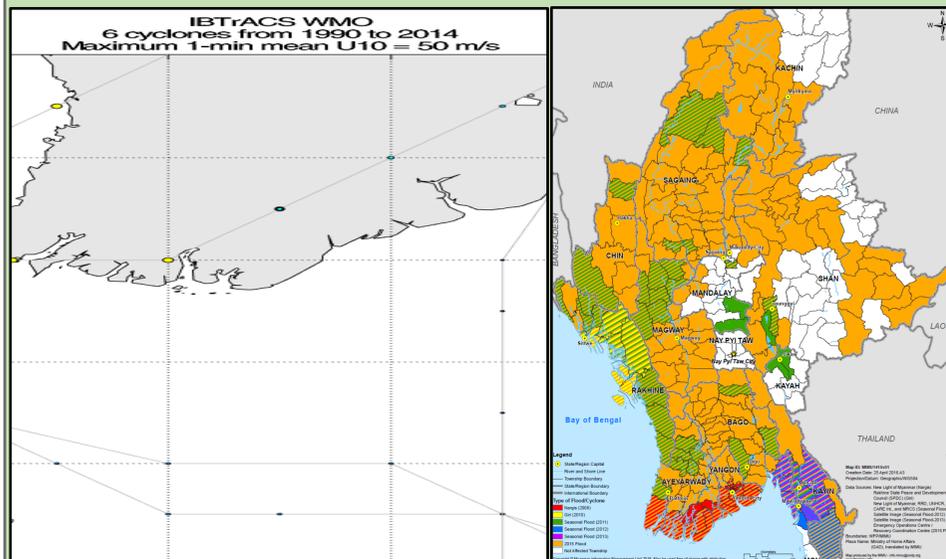


Site 3: Weather & Geology

Weather

- Cyclones are infrequent in this part of Myanmar, cyclones are deflected by the Andaman Islands.
- Flooding occurs on a seasonal basis.

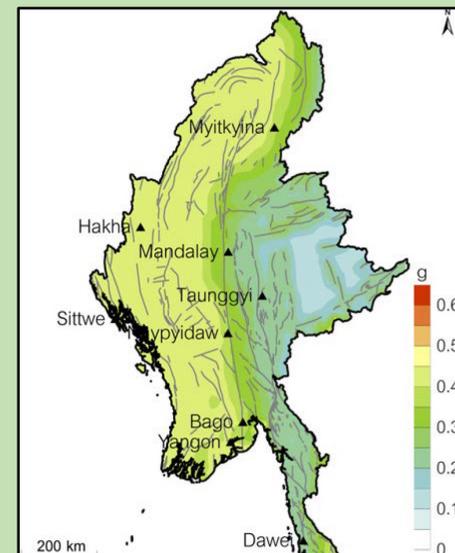
Cyclone tracks & flooding events



Geology

- There have been no recorded earthquakes in the vicinity of Kalegauk Island. There have been several Magnitude 4 – 5 earthquakes in the Andaman Sea to the west.
- Moderate peak ground accelerations are anticipated (<0.2g).

Peak ground accelerations



Site 3: Navigational assessment

- Site 3A is in 12 m of water + tides.
- No dredging is required if LNG transit times are controlled to high slack water.
- A dredged berthing pocket to 14 m sufficient for an LNG carrier to escape an incident will be required.
- Offshore site 3B is in a water depth of 20 m and presents no navigational issues.

Key Points



Heights In Metres Above Chart Datum

Tidal Condition	Mean High Water Spring Tides	Mean High Water Neap Tides	Mean Low Water Neap Tides	Mean Low Water Spring Tides
Tidal Height, m	5.5	3.9	2.5	0.9

Site 3: Environmental, Social & Cultural Impacts

- Kalgauk Island has 2 villages and 2 smaller settlements. Avoiding hazards and impacts is possible but restricts the space available.
- Fishing is important to Mon state but the muddy seabed here is probably of lower value than further south.

Key Points

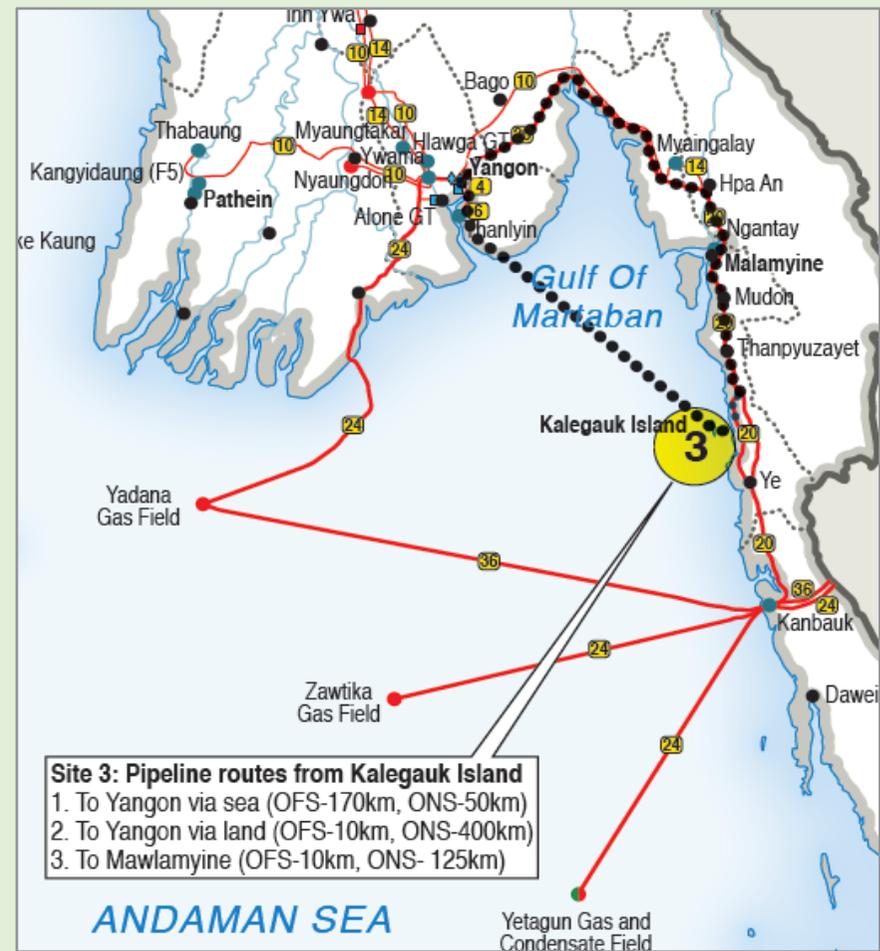
- 'Pristine' coast but developments are starting.
- Foreigners had no access until recently.
- Some deforestation by rubber plantations.



Site 3: Pipelines

- Current pipeline: Kaunbauk – Yangon via power stations at Mawlamyine.
- Reinforcement is underway but slow.
- Option 1 – 170 km of 30 inch subsea pipeline to Yangon + 50km onshore.
- Option 2 – 400 km of 30 inch pipeline in ROW to Yangon + 10km offshore.
- Option 3 – 125 km of 30 inch pipeline to Mawlamyine + 10 km offshore.
- Key assumptions are no compression or reinforcement requirements.

Key Points



Site 3: Local infrastructure

- No tugs, nearest tugs are at Shwe oil terminal.
- No port or port authority.
- Ye is the nearest town but is unable to provide the most basic business services.
- Little industry and relatively low skill workforce.
- Mawlamyine has higher education establishments.
- Health care at Ye is seen as poor
- Port at Mawlamyine for river traffic but with no significant port infrastructure.
- Good road & rail connections but these may be in poor condition.

Key Points

Ye has very limited infrastructure.



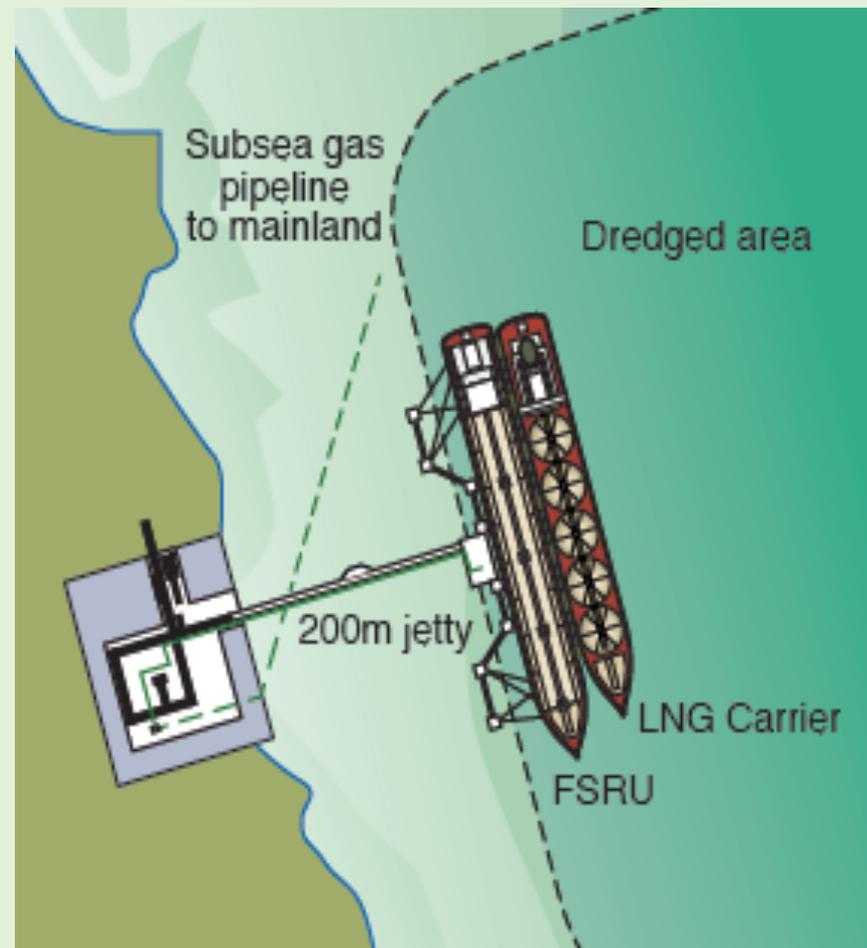
Site 3: Results – Kalegauk Island traffic light scoring

		Near shore Site 3A						Offshore Site 3B								
		Onshore terminal	FSRU on Jetty	Midwater FSRU	Deepwater FSRU	FSU on Jetty	LNGRV in Deepwater	GBS	Onshore terminal	FSRU on Jetty	Midwater FSRU	Deepwater FSRU	FSU on Jetty	LNGRV in Deepwater	GBS	
		GETTING LNG TO THE TERMINAL														
1	How much dredging is required to create a channel to the terminal?	Yellow	Yellow	Orange	Grey	Yellow	Grey	Orange	Grey	Grey	Orange	Grey	Grey	Grey	Orange	Grey
2	What Jetty length is required to be able to moor a near shore FSRU/LNG Carrier?	Green	Green	Grey	Grey	Green	Grey	Green	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Green
OR	What Subsea pipeline length is required to connect a midwater or deepwater FSRU or LNGRV	Grey	Grey	Green	Grey	Grey	Grey	Green	Grey	Grey	Green	Grey	Grey	Grey	Grey	Green
3	How much marine traffic is currently being experienced?	Green	Green	Green	Grey	Green	Grey	Green	Grey	Grey	Green	Grey	Grey	Grey	Grey	Green
4	Are there local visibility limitations?	Yellow	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Grey	Grey	Yellow	Grey	Grey	Grey	Yellow	Grey
5	Are there any other factors that limit the site?	Yellow	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Grey	Grey	Yellow	Grey	Grey	Grey	Yellow	Grey
STORING LNG																
1	What is the wave environment like?	Green	Green	Yellow	Grey	Green	Grey	Green	Grey	Grey	Yellow	Grey	Grey	Grey	Green	Grey
2	How variable is the wind/wave environment?	Green	Green	Yellow	Grey	Green	Grey	Yellow	Grey	Grey	Yellow	Grey	Grey	Grey	Yellow	Grey
3	Might the LNG facility be impacted by extreme weather?	Yellow	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Grey	Grey	Yellow	Grey	Grey	Grey	Yellow	Grey
4	Will the site cause any destruction or exclusion to environmentally sensitive areas?	Yellow	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Grey	Grey	Yellow	Grey	Grey	Grey	Yellow	Grey
5	Will the site cause any destruction or exclusion to culturally and historically sensitive areas?	Green	Green	Yellow	Grey	Green	Grey	Yellow	Grey	Grey	Yellow	Grey	Grey	Grey	Yellow	Grey
6	Will the site development and operation impact the local community in a detrimental way?	Yellow	Yellow	Orange	Grey	Yellow	Grey	Orange	Grey	Grey	Yellow	Grey	Grey	Grey	Orange	Grey
7	Will the site development and operation increase the risk of harm/fatality to the local community?	Yellow	Yellow	Green	Grey	Yellow	Grey	Green	Grey	Grey	Green	Grey	Grey	Grey	Green	Grey
8	Are there risks to the LNG facility from geological events?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey	Grey	Orange	Grey	Grey	Grey	Orange	Grey
GETTING GAS TO MARKET																
		Onshore pipeline						Subsea pipeline								
1	Can LNG be vaporised in sufficient volume and in an environmentally acceptable way?	Green	Green	Green	Grey	Green	Grey	Green	Grey	Grey	Green	Grey	Grey	Grey	Green	Grey
2	What is the onshore pipeline length?	Yellow	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Grey	Grey	Yellow	Grey	Grey	Grey	Yellow	Grey
3	What is the difficulty in laying the onshore pipeline?	Yellow	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Grey	Grey	Yellow	Grey	Grey	Grey	Yellow	Grey
4	What is the offshore pipeline length?	Green	Green	Green	Grey	Green	Grey	Green	Grey	Grey	Yellow	Grey	Grey	Grey	Yellow	Grey
5	What is the difficulty in laying the offshore pipeline?	Yellow	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Grey	Grey	Yellow	Grey	Grey	Grey	Yellow	Grey
LOCAL INFRASTRUCTURE																
1	Is there sufficient towage available to berth the LNG carrier?	Red	Red	Red	Grey	Red	Grey	Red	Grey	Grey	Red	Grey	Grey	Grey	Red	Grey
2	Is there currently any port rules and infrastructure appropriate to hydrocarbon importation at the proposed LNG site?	Red	Red	Red	Grey	Red	Grey	Red	Grey	Grey	Red	Grey	Grey	Grey	Red	Grey
3	Is there sufficient infrastructure to accommodate workers and their families, expatriates and vendor personnel?	Red	Red	Red	Grey	Red	Grey	Red	Grey	Grey	Red	Grey	Grey	Grey	Red	Grey
4	Is there emergency response and Health care capability?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey	Grey	Orange	Grey	Grey	Grey	Orange	Grey
5	Education and Skills?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey	Grey	Orange	Grey	Grey	Grey	Orange	Grey
6	Is there access to a major port with connecting roads?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey	Grey	Orange	Grey	Grey	Grey	Orange	Grey
7	Is there access to an international airport with road/rail links?	Orange	Orange	Orange	Grey	Orange	Grey	Orange	Grey	Grey	Orange	Grey	Grey	Grey	Orange	Grey
8	How adequate is the marine infrastructure?	Red	Red	Red	Grey	Red	Grey	Red	Grey	Grey	Red	Grey	Grey	Grey	Red	Grey

Site 3A: Technology Selection

- Any near shore solution based on a jetty.
- Mid water depth option is possible but significant additional dredging required so there is no advantage.
- Limited space on the island away from people which will make an onshore terminal challenging but its potential cannot be ruled out at this stage.
- Jetty moored FSRU is the most flexible option with a short delivery timescale.

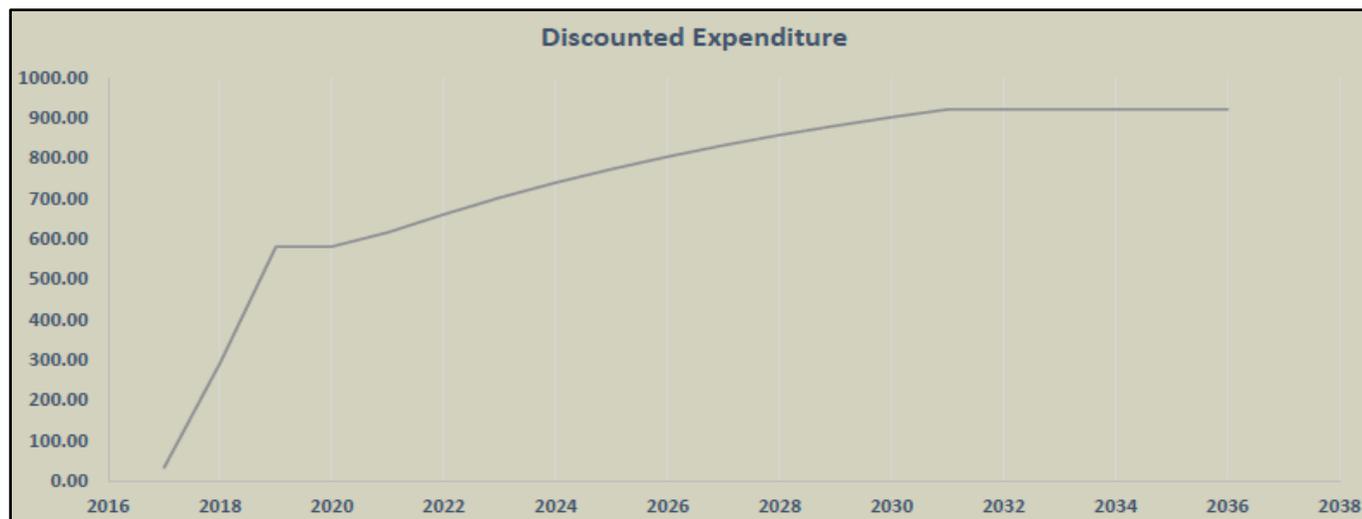
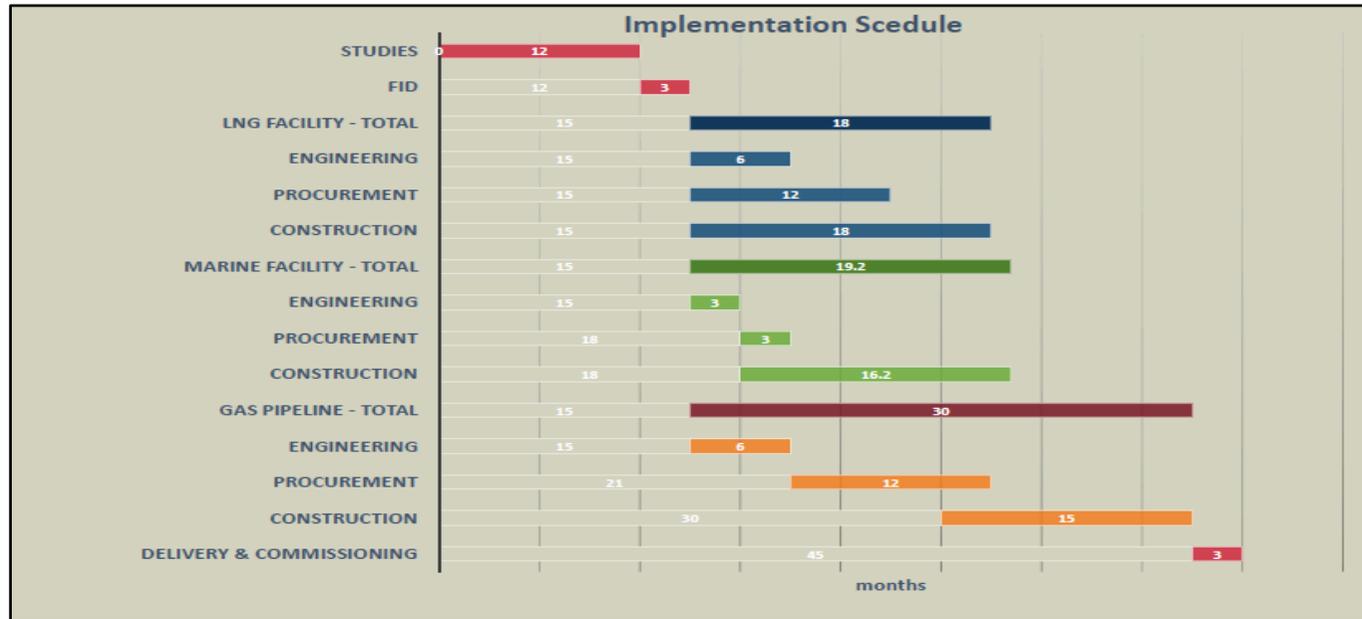
Technology selection



Site 3: Results – Summary data inputs for the analysis for Site 3A2

PHYSICAL PARAMETERS:		Data
LNG facility size		170,000 m ³ stored with 500 mmscfd vaporiser.
LNG facility type		FSRU
Location		Nearshore
Ownership		Lease
geology		<0.2 g acceleration
Jetty length		300 m
Breakwater		Not required
Dredging		450,000 m ³
Gas pipeline		10 km 30 inch subsea pipeline + 400 km onshore
Design LNG ship		163,000 m ³
FINANCIAL AND ECONOMIC PARAMETERS:		Data
Project start year		2017
LNG import term		10 years
Discount rate		10%
Lease rate		140,000 US\$/day
Fuel oil cost		470 US\$/ton 380 cs Singapore
Electricity cost		0.05 US\$/kWh (70 kyats/kWh)
Tug cost		US\$ 15,000/day each plus 4 days mobilisation
CAPITAL COSTS: Description of key areas		Value
FSRU		0 US\$ million (lease)
Mooring		167 US\$ million
Dredging		2.5 US\$ million
Gas pipeline		498 US\$ million
Local infrastructure		0 US\$ million
TOTAL		668 US\$ million
Note 1: No BOT/BOOT purchase payment was assumed at the end of the contract life.		
OPERATING COSTS: Description of key areas		Operating costs
FSRU lease		51 US\$ million pa
Fixed costs	Labour	3 US\$ million pa
	Insurance	2 US\$ million pa
	Inspection and maintenance	2 US\$ million pa
	Supporting infrastructure	0 US\$ million pa
Variable costs	Fuel oil	6.5 US\$ million pa
	Electricity	0 US\$ million pa
	Towage	14.6 US\$ million pa
TOTAL		80.2 US\$ million pa
Notes		
1. The above calculation is based on a gas pipeline to Yangon. If an intermediate solution was developed with the onshore pipeline stopping at Mawlamyine only 125km from where RLNG is landed from the FSRU a saving of around \$330million would be possible.		

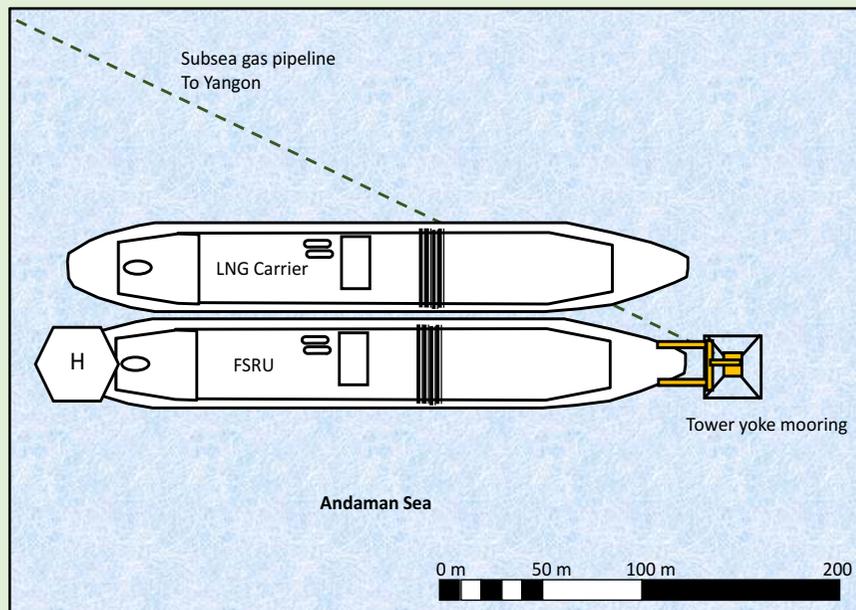
Site 3: Results – Implementation schedule and cash flow 3A2



Site 3B: Technology Selection

Technology selection

- The variability in wave direction is small so an island jetty may be possible although wave heights will marginally limit availability.



Technology selection

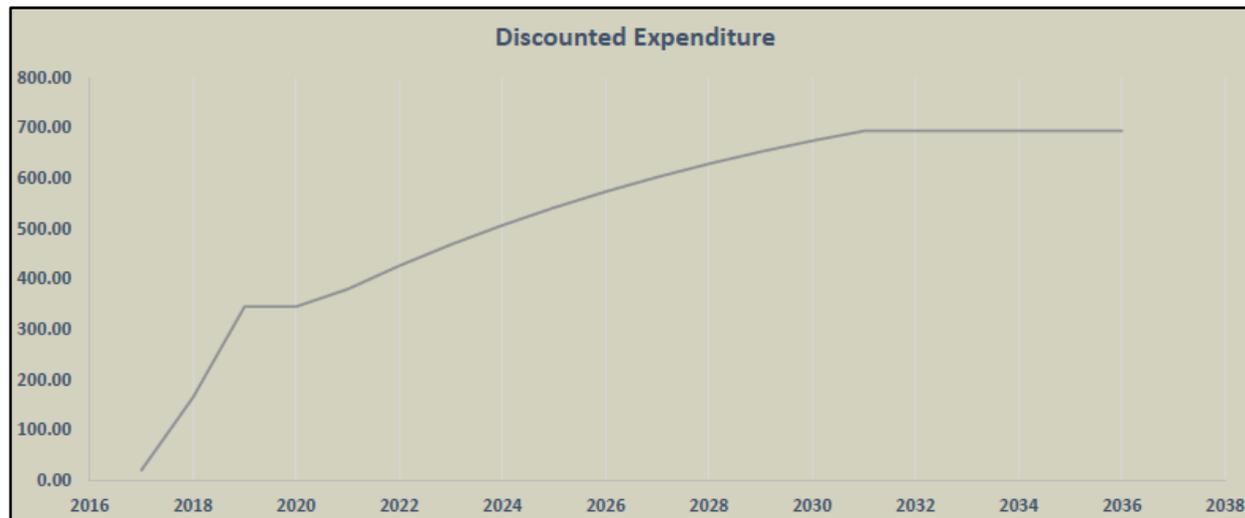
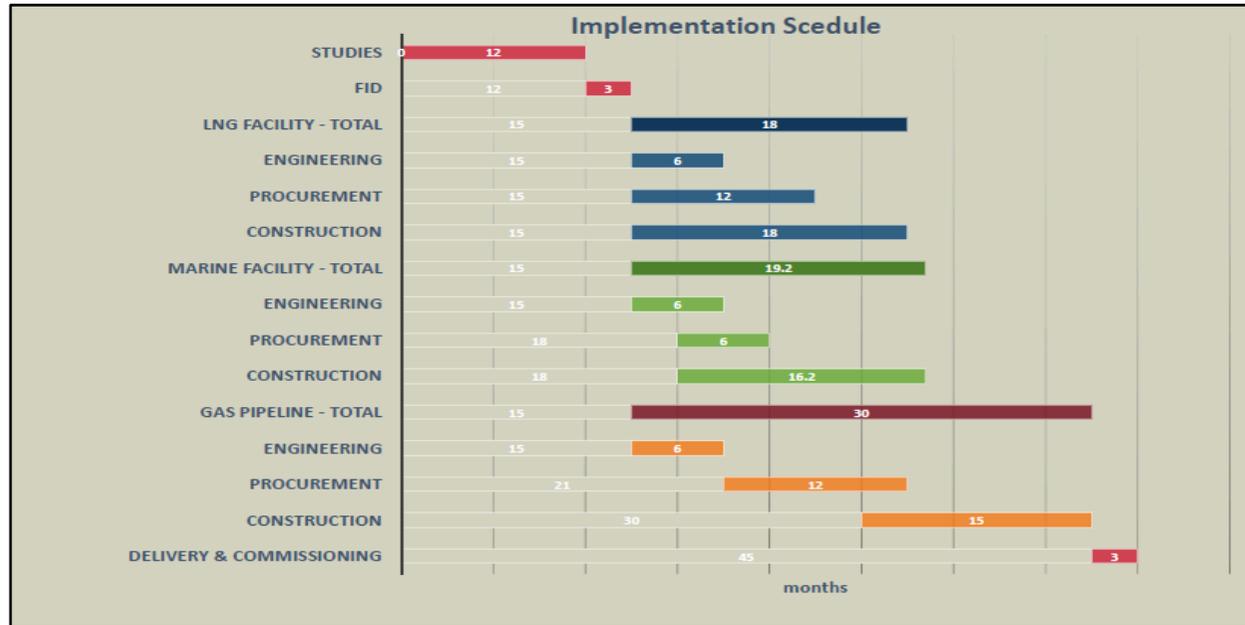
- Water depth is about 20 m and relatively exposed so a tower yoke mooring is preferred.



Site 3: Results – Summary data inputs for the analysis for Site 3B2

PHYSICAL PARAMETRS:		Data
LNG facility size		170,000 m3 stored with 500 mmscfd vaporiser
LNG facility type		FSRU
Location		Mid water
Ownership		Lease
geology		<0.2 g acceleration
Jetty length		Not required
Breakwater		Not required
Dredging		Not required
Gas pipeline		170km 30 inch subsea pipeline + 50 km onshore
Design LNG ship		163,000 m ³
FINANCIAL AND ECONOMIC PARAMETERS:		Data
Project start year		2017
LNG import term		10 years
Discount rate		10%
Lease rate		140,000 US\$/day
Fuel oil cost		470 US\$/ton 380 cs Singapore
Electricity cost		0.05 US\$/kWh (70 kyats/kWh)
Tug cost		US\$ 15,000/day each plus 2 days mobilisation
CAPITAL COSTS: Description of key areas		Value
FSRU		0 US\$ million (leased)
Mooring		31 US\$ million
Dredging		0 US\$ million
Gas pipeline		366 US\$ million
Local infrastructure		0 US\$ million
TOTAL		397 US\$ million
Note 1 : No BOT/BOOT purchase payment was assumed at the end of the contract life.		
OPERATING COSTS: Description of key areas		Operating costs
FSRU lease		51 US\$ million pa
Fixed costs	Labour	3 US\$ million pa
	Insurance	2 US\$ million pa
	Inspection and maintenance	2 US\$ million pa
	Supporting infrastructure	2.2 US\$ million pa
Variable costs	Fuel oil	6.48 US\$ million pa
	Electricity	0 US\$ million pa
	Towage	14.5 US\$ million pa
TOTAL		81.4 US\$ million pa

Site 3: Results – Implementation schedule and cash flow 3B2



Site 3: Results Summary

Site 3A2

- Schedule to market: 48 months
 - Capital Cost: 668 US\$ million
 - Operating cost: 80 US\$ million/year
 - Discounted Expenditure: 948 US\$ million
- 400 km onshore pipeline to Yangon, a shorter pipeline to Mawlamyine may be possible

Site 3B2

- Schedule to market: 48 months
 - Capital Cost: 397 US\$ million
 - Operating cost: 81 US\$ million/year
 - Discounted Expenditure: 720 US\$ million
- 170 km subsea pipeline connecting to 50 km onshore pipeline

Section 7: Conclusions and Recommendations

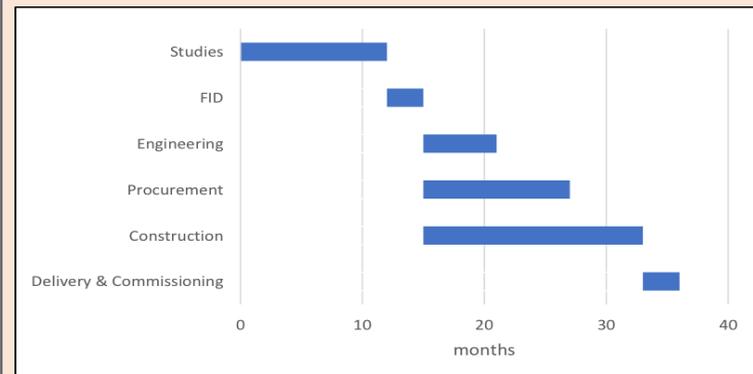
Conclusions - Schedule

All sites similar in terms of schedule

- LNG supply possible in 3-4 years includes
 - 1 year of studies, permitting and financing.
 - 2-3 years of engineering, procurement and construction.
- Engineering, procurement & construction
 - FSRU 18 - 24 months
 - Marine jetty/dredging 18 – 24 months
 - Gas pipeline 24 - 30 months
- Schedule should coincide with newbuild FSRU currently under consideration coming to market.

Schedule

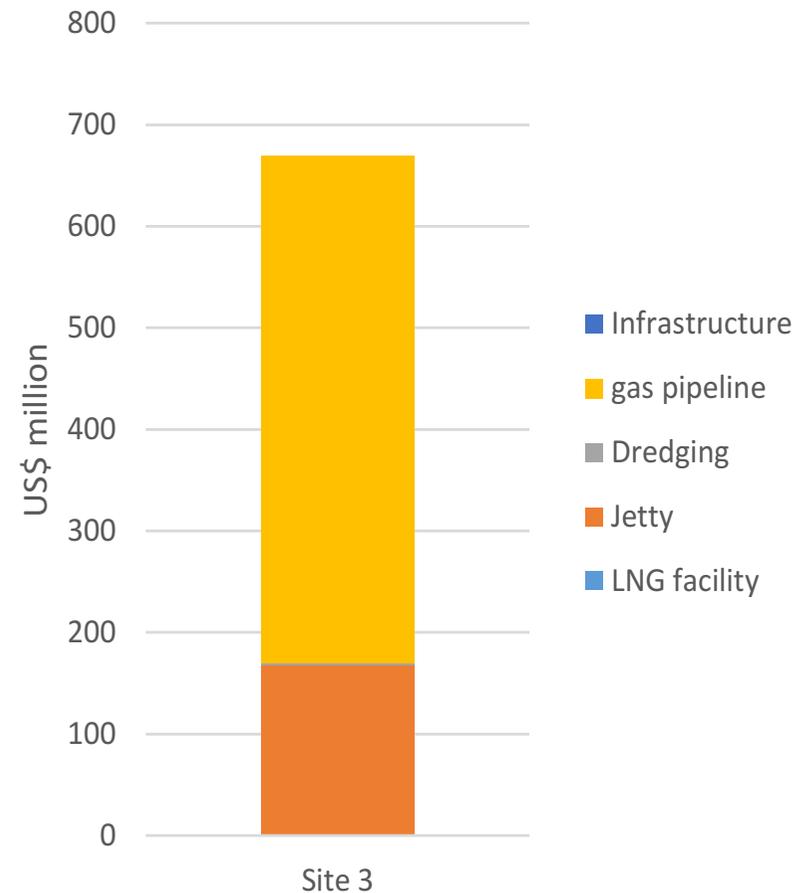
FSRU/LNG is not the rate determining step.



Conclusions – Capital Investment

- The FSRU is presumed to be on a leased basis.
- Capital investment required for
 - Marine facilities.
(May include in FSRU package)
 - Gas pipelines.
- Operating costs are anticipated to be US\$ 60 - 80 million pa including the FSRU lease.
- US\$ 140,000 per day assumed for lease (US\$ 51 million pa).

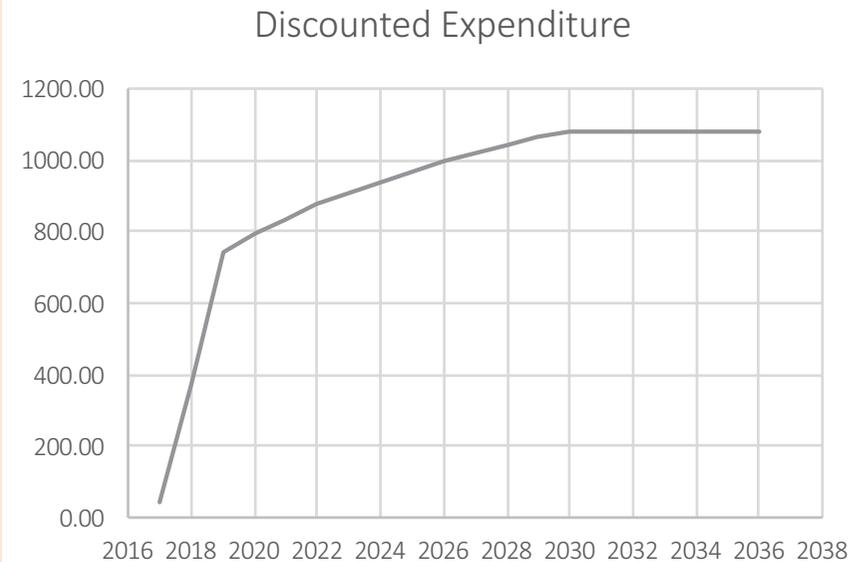
Capex breakdown



Conclusions – DCF numbers

- To compare capital costs with operating costs over the lifetime of the LNG lease/import contract an NPV model has been used.
- As no LNG price/sales income estimates are part of the scope of work a view can only be taken of discounted expenditure.

Cash flow model



Conclusions – Site comparison

Site	Schedule	Capital Investment	Operating Expense	Discounted Expenditure
Site 1A2	48 months	826 US\$ million	66 US\$ million pa	1,032 US\$ million
The above calculation is based on a 557km connecting pipeline to Yangon. If Site 1A2 was to opt for the shorter 290km onshore connection to either Pyay or Magway the CAPEX costs would be reduced by \$320.4 million, with an equivalent reduction in the DCF figure.				
Site 2D	48 months	350 US\$ million	80.3 US\$ million pa	682 US\$ million
The above calculation is based on a 230km connecting pipeline to Yangon. If Site 2D was to opt for the shorter 50km onshore connection to Pathein the CAPEX costs would be reduced by \$204 million, with an equivalent reduction in the DCF figure.				
Site 3A2	48 months	668 US\$ million	80.2 US\$ million pa	948 US\$ million
The above calculation is based on a gas pipeline to Yangon. If an intermediate solution was developed with the onshore pipeline stopping at Mawlamyine only 125km from where RLNG is landed from the FSRU a saving of around \$330million would be possible.				
Site 3B2	48 months	397 US\$ million	81.4 US\$ million pa	720 US\$ million
No comments.				

Schedules and costs (+/-50%) for each site examined are shown in the table.

Notes:

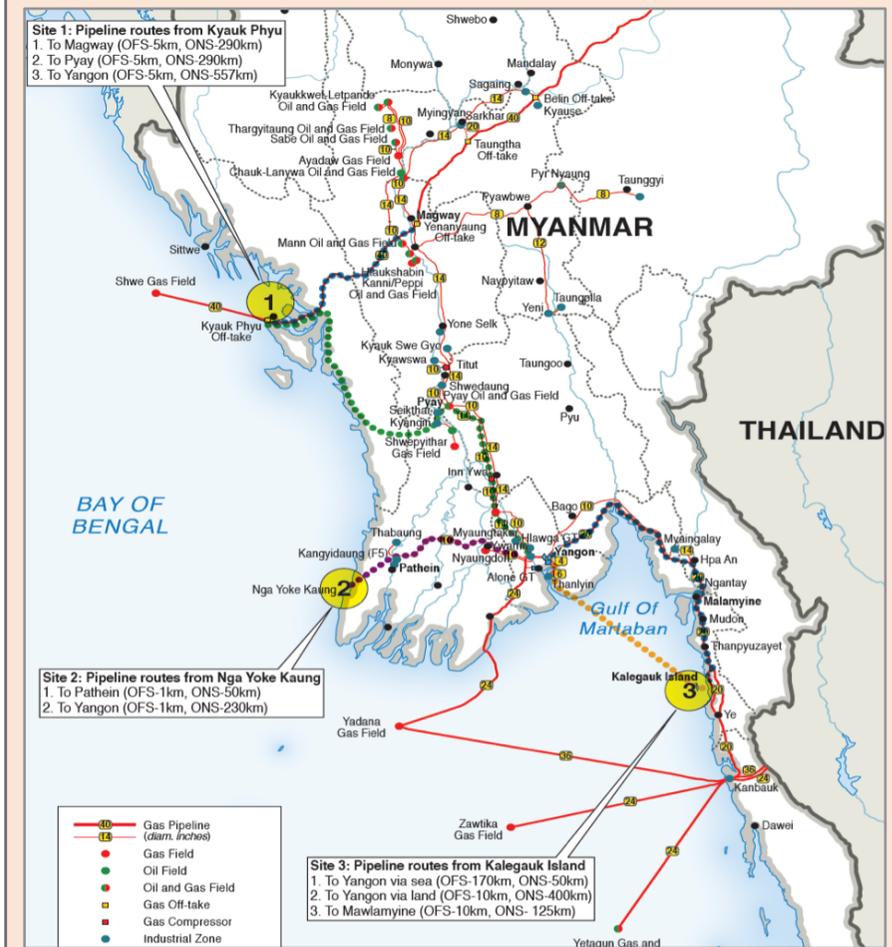
- Site 1A new pipeline from Magway to Yangon (via Shwe) or direct to Yangon.*
- Site 2C has a relatively low metocean availability of 85%.*
- Site 2D needs to find a solution for getting a subsea pipeline past coral.*
- Site 3A could use a subsea pipeline direct to Yangon which improves economics.*

Conclusions – Site selection

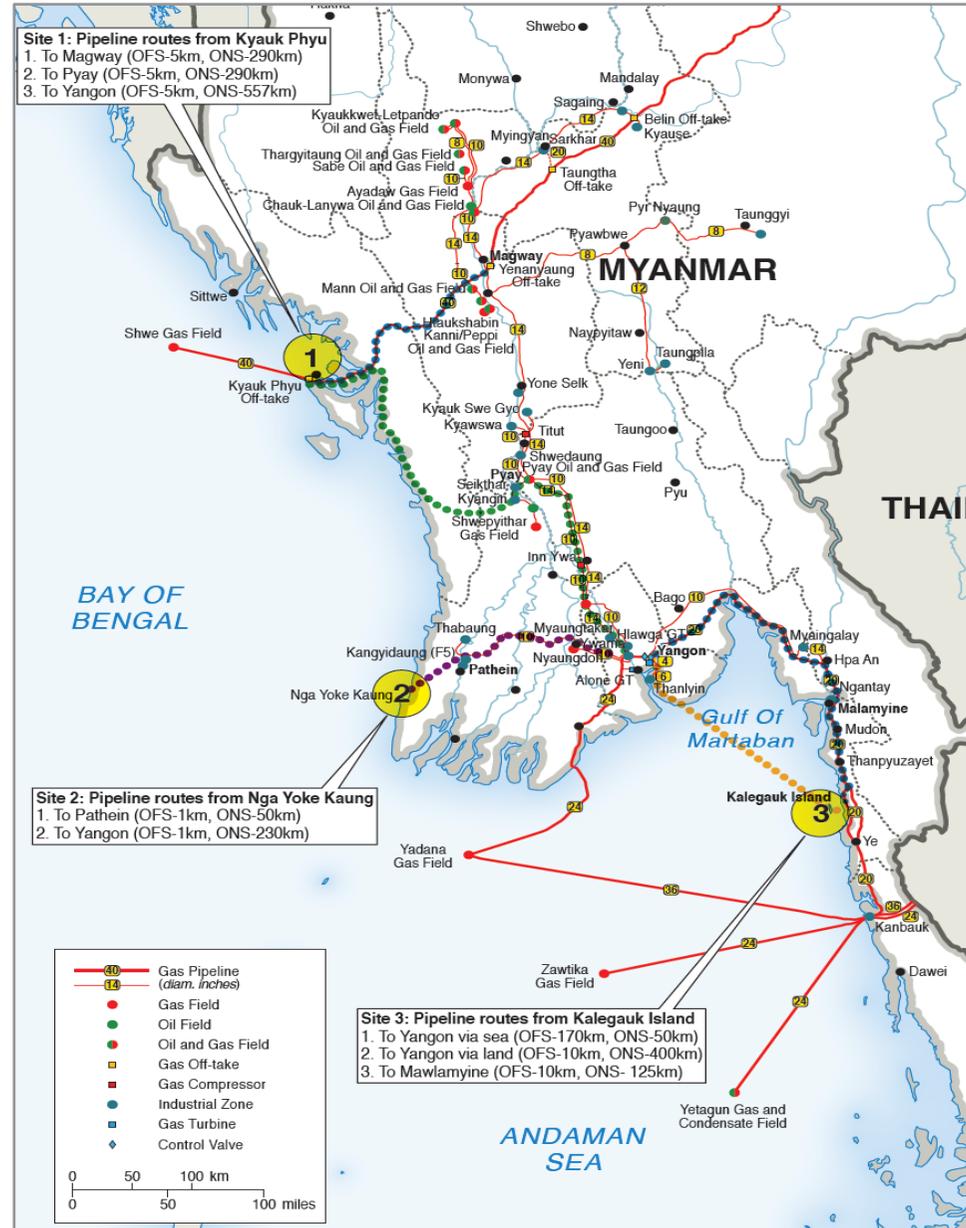
Four sites were shortlisted and examined in more detail.

- Site 1A looks a good site but pipeline is long.
- Site 2D – Is the cheapest route to Yangon but there may be environmental concerns and delays.
- Site 3A looks the best marine site but an onshore pipeline route to Yangon is long.
- Site 3B is a compromise with the subsea pipeline option across the Gulf of Martaban looking promising.

Site options



Site selection conclusions



Schedule Conclusions

- LNG infrastructure is not on the critical path for most options.
 - There are no unchartered FSRUs available until 2019-20.
- Gas pipelines can be on the critical path but are always close to the critical schedule.
 - Marine facilities and gas pipelines can be accelerated by working on multiple fronts but this may have a cost impact.
 - Procurement of material/equipment is a key issue and although schedules are improving still represents a bottleneck.

Key Points

Permitting and financing will take longer than engineering pre FID.



Cost Conclusions

- All options use an FSRU.
 - This is assumed to be leased for a period of 10 years.
 - There is no capital expenditure associated with the FSRU.
- All capital expenditure is for onshore/shoreline facilities.
 - Pipeline expenditure dominates capital investment.
- Operating costs are dominated by fuel/electricity.
- Towage costs will be high if tugs need to travel some distance to the LNG facility.

Lease rates

Lease rates become significant over the charter lifetime.

A rate of US\$ 140,000/day has been used.

This is the upper end of the current range but FSRUs are in short supply so rates may rise further.

Future work

More detailed work will be required in the following areas.

- The site location including:
 - Bathymetric and topological surveys.
 - Calibrated metocean assessments preferably using measured wave data.
 - Environmental and social studies.
- LNG supply strategy:
 - MOGE need to have a clear understanding of how much LNG volume is to be imported, at what rate and over what period.
- FSRU design and availability.
 - A detailed design feasibility study for the FSRU.
- Onshore gas transportation.
 - A detailed design feasibility for the offshore and onshore pipelines taking into account road and river crossing, difficulty of terrain and local system reinforcement costs.

The limits of this study

Ideally the Consultants would have preferred to have met with the marine authorities and visited the proposed sites.

The pipeline costs are based on broad \$million/km and no allowance has been made for difficult terrain or road and river crossings.

Future work

- This study is based on piping gas to Yangon for power.
- An alternative option would be to produce electricity more locally and transmit by wires.
- Site 1 could use the Shwe pipeline to Mingian for a northern power hub.
- Site 2 would continue to pipe gas to Yangon for power generation.
- Site 3 could be piped to Mawlamyine for a southern power hub.
- Economics of Sites 1 and 3 would be improved

A future study should consist of the following

Compare energy transmission by wire compared to energy delivery by pipe.

Thank you

Any questions?

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