Phase 1 Prospective and Phase 2 Pacesetter Evaluations of the Samarang Project

Prepared for PETRONAS

Prepared by
Adrian Kong and Trung Ghi

April 2010

FINAL

IPA INDEPENDENT PROJECT ANALYSIS, INC.

Confidentiality Statement

PET-0201-PAC and PET-0202-PRO

Prepared by Adrian Kong and Trung Ghi

Reviewed by Randall Monk

Edited by Paul Gugino

April 2010 – FINAL

Preface

- **Members of PETRONAS-Schlumberger alliance project team supplied information in meetings on 24 and 25 February 2010, in Kuala Lumpur**
- **Although project team members provided information, interpretation and analysis are IPA's and do not necessarily reflect views of those interviewed**
- **For more information, contact**
  - **Adrian Kong at +65 6567 2201 or at akong@ipaglobal.com**
  - **Trung Ghi at +61 3 9458 7315 or at tghi@ipaglobal.com**

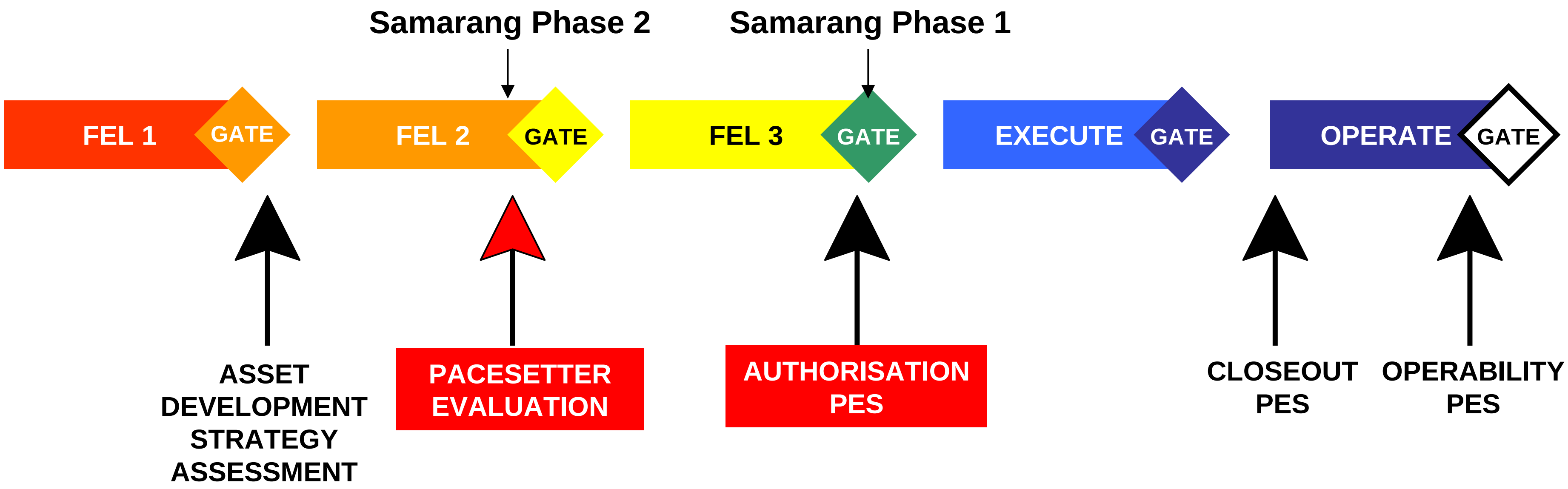
Objectives of Pacesetter Analysis

- Provide feedback to PETRONAS on status of Samarang Project Phase 2 at end of Front-End Loading (FEL) 2
- Identify definition gaps that should be completed before entering FEL 3
- Provide benchmarks for project cost and schedule targets
- Determine and identify areas of risk
- Present recommendations for risk reduction and performance improvement
- Help project team set up Define Phase and execute successful project

Objectives of Prospective Analysis

- Provide feedback on Samarang Project Phase 1 status at authorisation
  - Determine if FEL and other drivers meet Best Practice
  - Identify gaps that may preclude project excellence
- Provide benchmarks of project cost, schedule, and operability expectations
- Share research to identify areas of risk and offer mitigation strategies
- Present recommendations for risk reduction and performance improvement
- Help project team to set up and execute a successful project

When Does IPA Get Involved in Projects?



- **Pacesetter Project Evaluation to set targets, identify Best Practices, and quantify cost/schedule risks early**
- **Authorisation Project Evaluation when estimating data are available, support DSP for Development Stage**
- **Closeout after startup, but prior to team being reassigned**
- **Operability after first year of operation**

Outline

- *Key Message*
- **Project Background**
- **Basis of Comparison**
- **Practices and Drivers**
- **Targeted Outcomes**
- **Conclusions**
- **Recommendations**

Key Message
Samarang Project – Phase 1

- **Phase 1 has strong definition for reservoir, wells and facilities – project targets and risks need to be reviewed prior to authorisation**
- **Conservative cost and schedule targets set**
- **Despite conservative schedule, team faces risk of schedule delays if project does not get approval and ready to award HUC* contract by June 2010**
- **Lack of operations representation on team may drive interface issues that will surface during execution**

***HUC – hookup & commissioning**

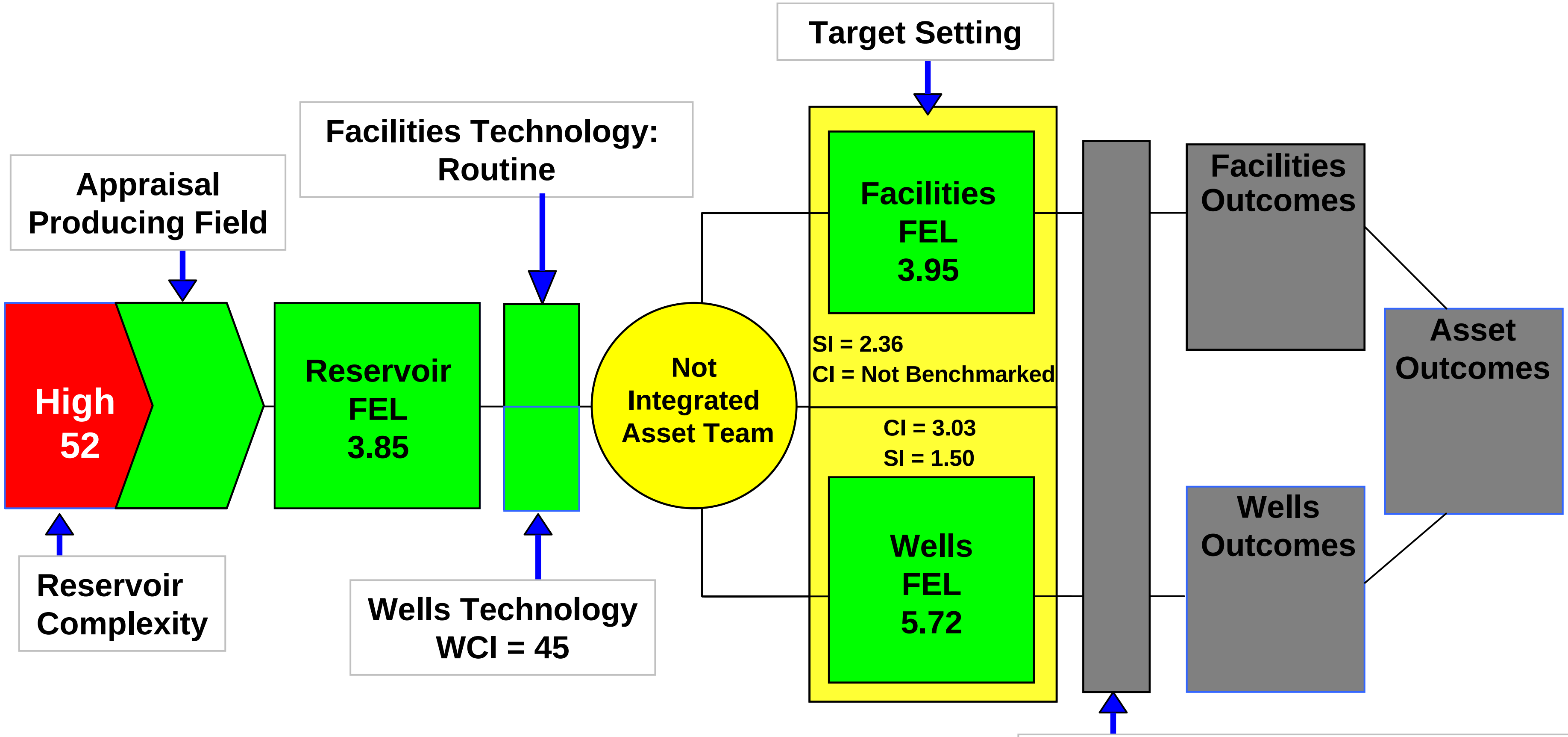
Key Message
Samarang Project – Phase 2

- **Phase 2 has achieved optimal definition at end of FEL 2 except for facilities – however, key risks need to be addressed prior to FEED***
- **EOR** scope viability highly depends on results of injectivity tests and core analysis of Phase 1**
- **Given high overlap between subsurface analysis and Phase 2 FEED, team faces risk of late changes for Phase 2**
  - **May ultimately affect viability of EOR scope**
- **Definition of success for GASWAG^ EOR must be developed**

*FEED – front-end engineering design
**EOR – Enhanced Oil Recovery
^GASWAG – Gravity Assisted Simultaneous Water and Gas

Summary of Samarang Project Phase 1

Authorisation Evaluation



Risk	<<< Less	--------	More >>>
Results	<<< Better	--------	Worse >>>

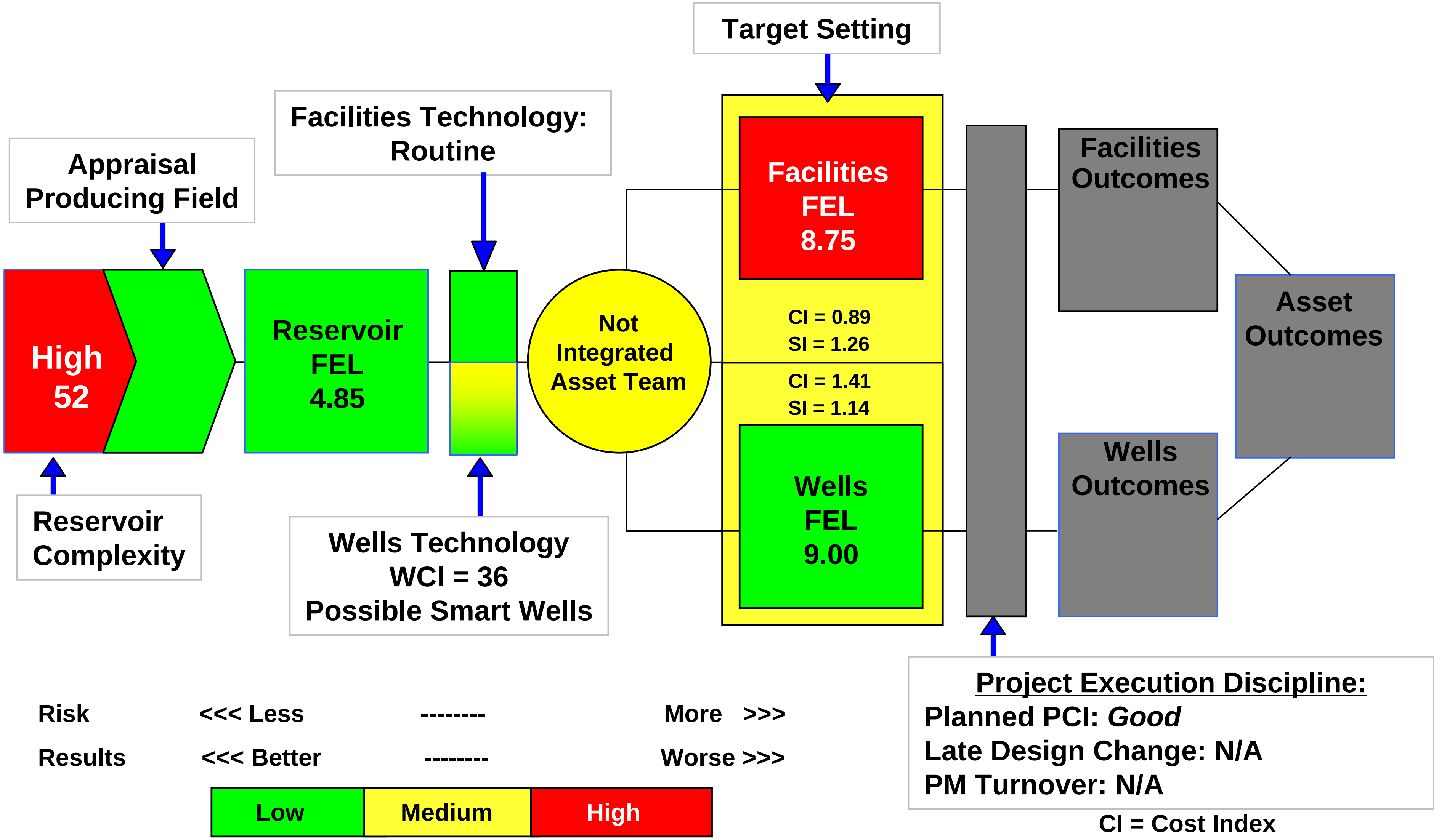
Low	Medium	High

Project Execution Discipline:
Planned PCI: *Good*
Late Design Change: N/A
PM Turnover: N/A

CI = Cost Index
SI = Schedule Index
PDA = Production Attainment

Summary of Samarang Project Phase 2

End of Concept Select Phase Evaluation



CI = Cost Index
SI = Schedule Index
PDA = Production Attainment

Outline

- **Key Message**
- ***Project Background***
- **Basis of Comparison**
- **Practices and Drivers**
- **Targeted Outcomes**
- **Conclusions**
- **Recommendations**

Project Background
Field Summary

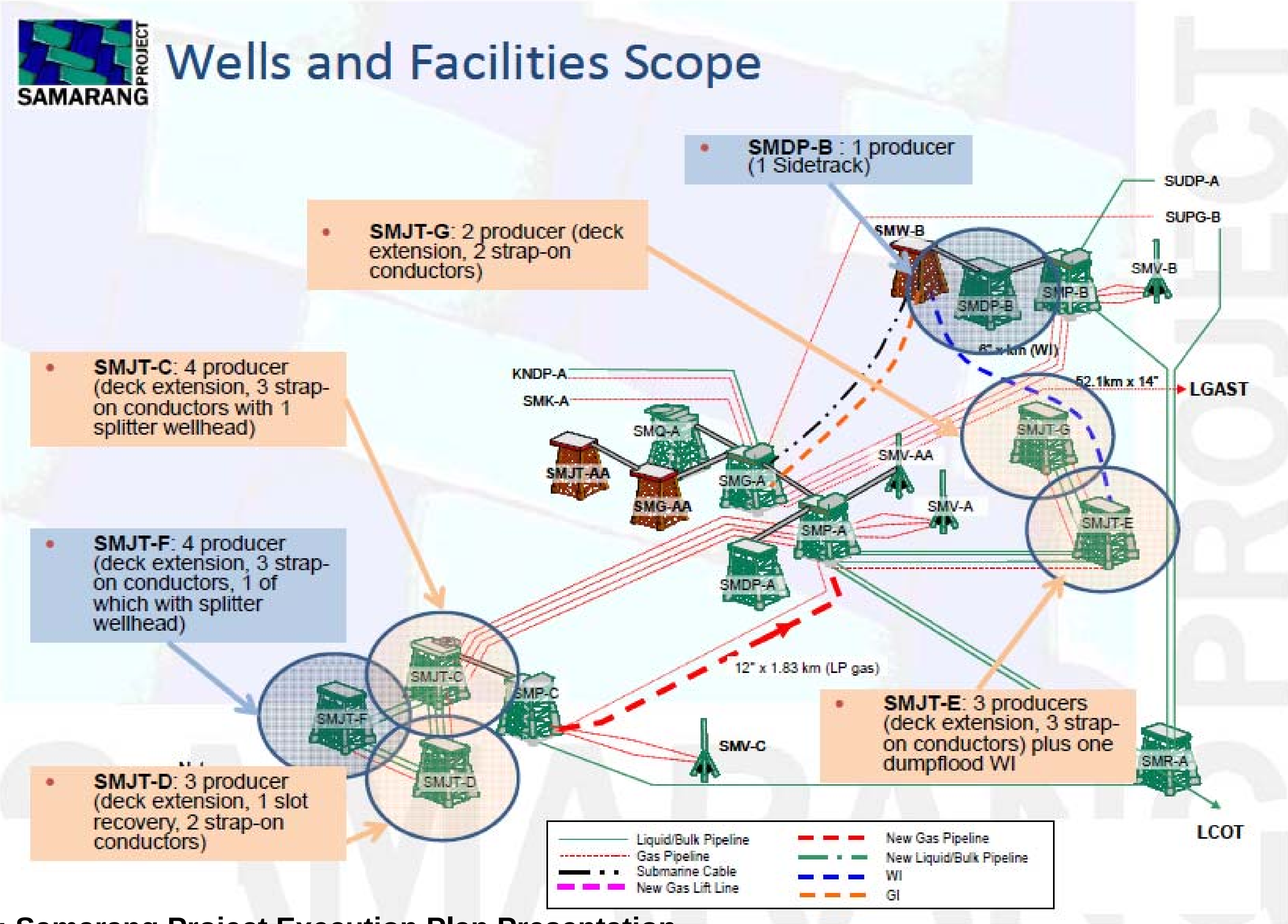
- **Samarang field is in South China Sea off coast of Sabah, East Malaysia, about 72 km northwest of Labuan Gas terminal; field covers about 7 km X 2 km**
- **Samarang field discovered in 1972 by SM-1 well and was developed in phases – first oil achieved in June 1975**
- **Existing Samarang complex comprised of 7 platforms (drilling, wellhead platforms, processing platforms, etc.)**
- **Shell was previous operator and relinquished concession to PCSB* in April 1995**
- **Current production license for Samarang field will expire in 2020**

*** PCSB – Petronas Carigali Sdn Bhd**

Project Background
Drilling History

- **In late 1997, Samarang was upgraded as hub**
  - **Several offset fields (including Kinabalu, Samarang Kecil, and Sumandak) were tied in Samarang facilities and shared export line to LCOT and LGAST**
- **Total of 62 development wells drilled from 1975-1979 on SMDP-A, B and SMJT-C, D, E platforms**
- **Several revisits since were made to field:**
  - **1986/87: 12 wells (SMJT-f, G) and 20 sidetracks on SMDP-A, B and SMJT-C, D, and E**
  - **1991/93: 27 sidetracks – 3 of which were workover and 2 were new wells on SMDP-A, B; SMJT-C, D, and F**
  - **1997/98: 3 sidetrack wells, 1x HHP gas and 5 new wells in SMJT-D, F, and G**
  - **2002: 2 sidetracks (SM-52 and SM-57) and one recompletion (SM-42)**

Project Background
Overall Samarang Project Scope (1)



Source: Samarang Project Execution Plan Presentation

Project Background

Overall Samarang Project Scope (2)

Infill Drilling and Associated Facilities

- **18 new producers**
- **New SMG-AA gas processing platform**
- **12”x 1.8 km gas pipeline from SMP-C to SMP-A**
- **Modifications on 11 existing platforms:**
  - **Jackets strengthening**
  - **Slot recovery on SMJT-D, deck extensions and installation of strap-on conductors on selected wellhead platforms (WHPs: SMJT-C, SMJT-D, SMJT-E, SMJT-F & SMJT-G)**
  - **Upgrade of wellhead control panels (WHCP)**
  - **Upgrade/revamp of existing equipment including separator internals, pump replacements, etc.**

Project Background
Overall Samarang Project Scope (3)

- **EOR and Associated Facilities**
- **5 water injector wells and 6 gas injector wells**
- **New 9-slot SMJT-AA WHP**
- **New SMW-B water processing and injection platform**
- **2 new pipelines and submarine cable**
  - **6”x2 km gas Injection pipeline from SMG-AA to SMW-B**
  - **6”x2 km water injection pipeline from SMW-B to SMJT-E**
  - **Submarine cable from SMG-A to SMW-B**

Project Background
Execution Strategy

- **Samarang Project will be executed in two phases**
  - **Phase 1: 5 infill wells and associated revamp of existing facilities**
  - **Phase 2: develop remaining infill and EOR scopes**
- **Project cost estimate is about US$1 billion**
  - **Phase 1: US$130 million* (excluding PE scope)**
  - **Phase 2: US$879 million**
- **Phases have separate final investment decisions (FIDs)**
  - **Phase 1 planned FID in May 2010^**
  - **Phase 2 planned FID in July 2011**
- **Project team is leveraging GASWAG EOR technology through Schlumberger alliance contract**

***Total costs for Phase 1 including PE scope is US$286 million – PE scope is executed by operations and not included in this evaluation**

^Authorisation date of May 2010 as indicated by project team during Draft presentation

Outline

- Key Message
- Project Background
- ***Basis of Comparison***
- Practices and Drivers
- Targeted Outcomes
- Conclusions
- Recommendations

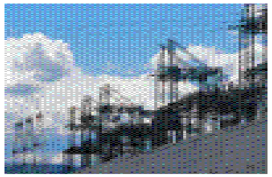
IPA Proprietary Databases

PES SMALL PROJECTS
2,300+ projects
Projects <$7MM from process industries

PROCESS PLANTS PES
12,000+ projects
Detailed histories of process plant projects >$5MM

HAZRISK
400+ projects
Environmental assessments and cleanups

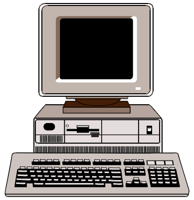
MEGAPROJECTS
100+ projects
$Billion class projects, all types



POWER PLANTS
36 projects
Single or combined cycle plants

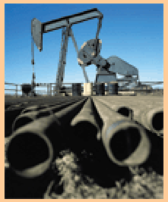
PLANNED TURNAROUNDS
200+ projects
Facility turnarounds

INFORMATION TECHNOLOGY
250+ projects; including Applications Development, Telecommunication, etc.



INSTRUMENTATION & CONTROL
70+ projects
Automation, DCS, SCADA, etc.

UPSTREAM PES
1,000+ projects
Platform, Subsea, Floaters, Subsurface, Drilling



PIPELINES
500+ projects
Pipelines, terminals, booster stations, etc.

UIBC 2009 Database

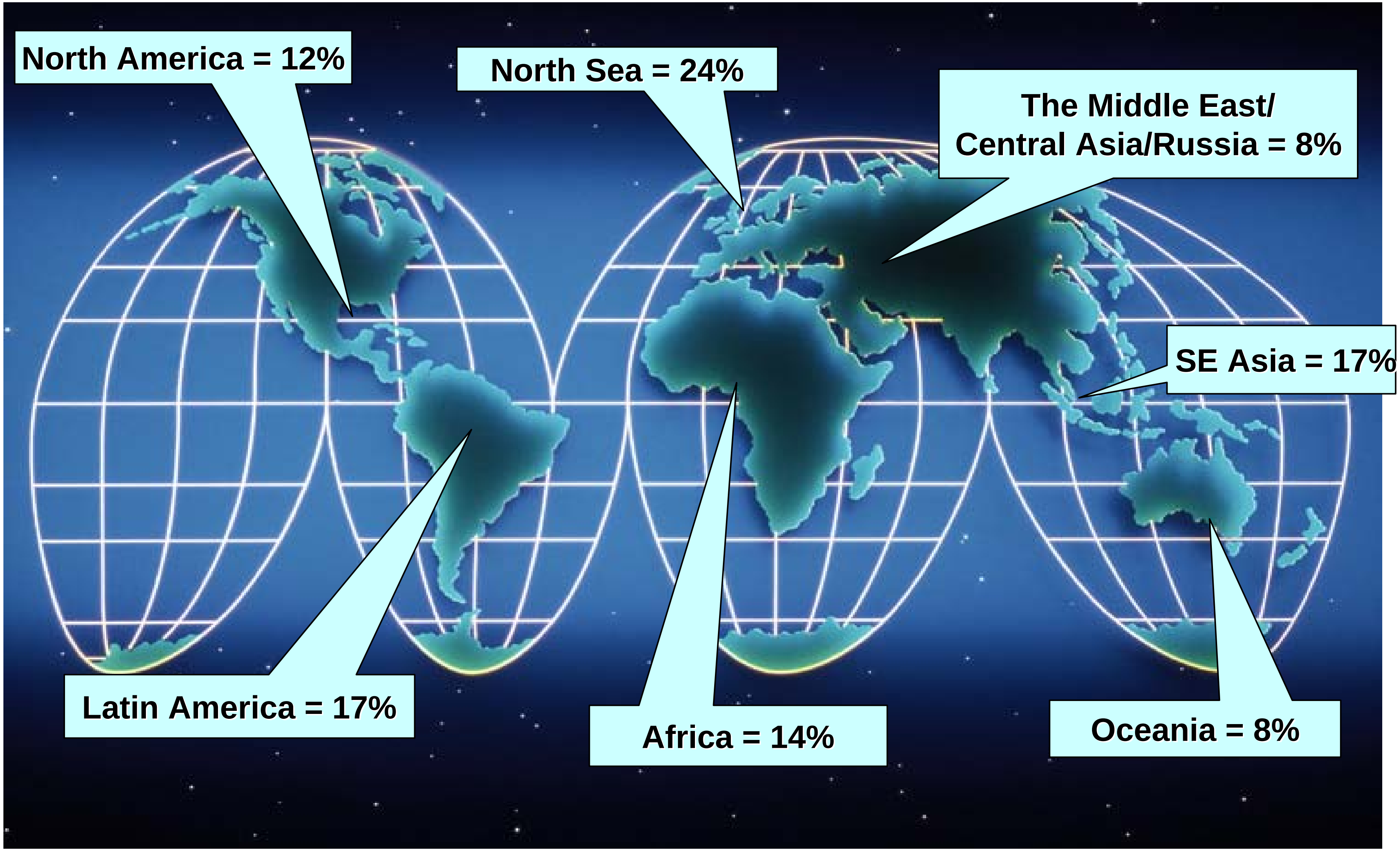
Basis for E&P Industry Averages

OVERALL PROJECT DATA	• 396 projects
MEDIAN AUTHORISATION DATE	• 2004 (2001 to 2009)
FACILITIES COST (^{2009}\$) *(Includes Export)*	• Average: \$657 million • Range: Less than \$6 million to more than \$8.3 billion
WELL CONSTRUCTION (^{2009}\$)	• Average: \$438 million • Range: Less than \$5 million to more than \$4.7 billion

Note:

1. UIBC = Upstream Industry Benchmarking Consortium
2. Costs are in US dollars

UIBC 2009 Database Is Global



Operators in IPA's E&P Benchmarking

Majors and Independents

Anadarko
Apache
BG Group
BHP Billiton
ConocoPhillips
Hess
INPEX
Marathon
Medco Energi
Nexen
Noble Energy
Pioneer
Santos
Sasol E&P
Talisman Energy
W&T Offshore
Woodside

National Oil Companies or Partial State Ownership

ADNOC
AIOC
CNOOC
ENI
Ecopetrol
Oman Oil
PDVSA
Petrobras
Petrochina
Petronas
PTTEP
Repsol
Saudi Aramco
Statoil

Super Majors

BP
Chevron
ExxonMobil
Shell
Total

** Company names in red indicate IBC and/or UIBC member companies*

Basis of Comparison
Platforms

Characteristic	SMJT-AA	SMG-AA	Dataset (332 projects)		
			Minimum	Median	Maximum
Year of Authorisation	2011		1988	2001	2008
Region	Southeast Asia		Europe, 19%; GoM, 18%; Africa, 16%; SE Asia, 26%; Other, 21%		
Actual Cost ($\$^{MOD}$ million)	34 (estimated)	320 (estimated)	2	30	> 1,500
Water Depth (m)	10	10	2	32	> 300

Basis of Comparison
Pipelines

Characteristic	Gas Injection	Water Injection	Gas Pipeline	Dataset (402 projects)		
				Minimum	Median	Maximum
Year of Authorisation	2011			1989	2000	2008
Region	Southeast Asia			GoM, 29%; Europe, 25%; Asia, 15%; Africa, 12.5%; South America, 14%; Middle East, 2%; Other, 2.5%		
Actual Cost ($^{MOD} million)	8 (Estimated)	8 (Estimated)	9 (Estimated)	0.7	26	972
Pipeline Diameter (in)	6	6	12	4	12.75	51
Pipeline Length (km)	2	2	1.8	0.4	19.8	869
Water Depth (m)	50	50	50	4.37	84	2,155

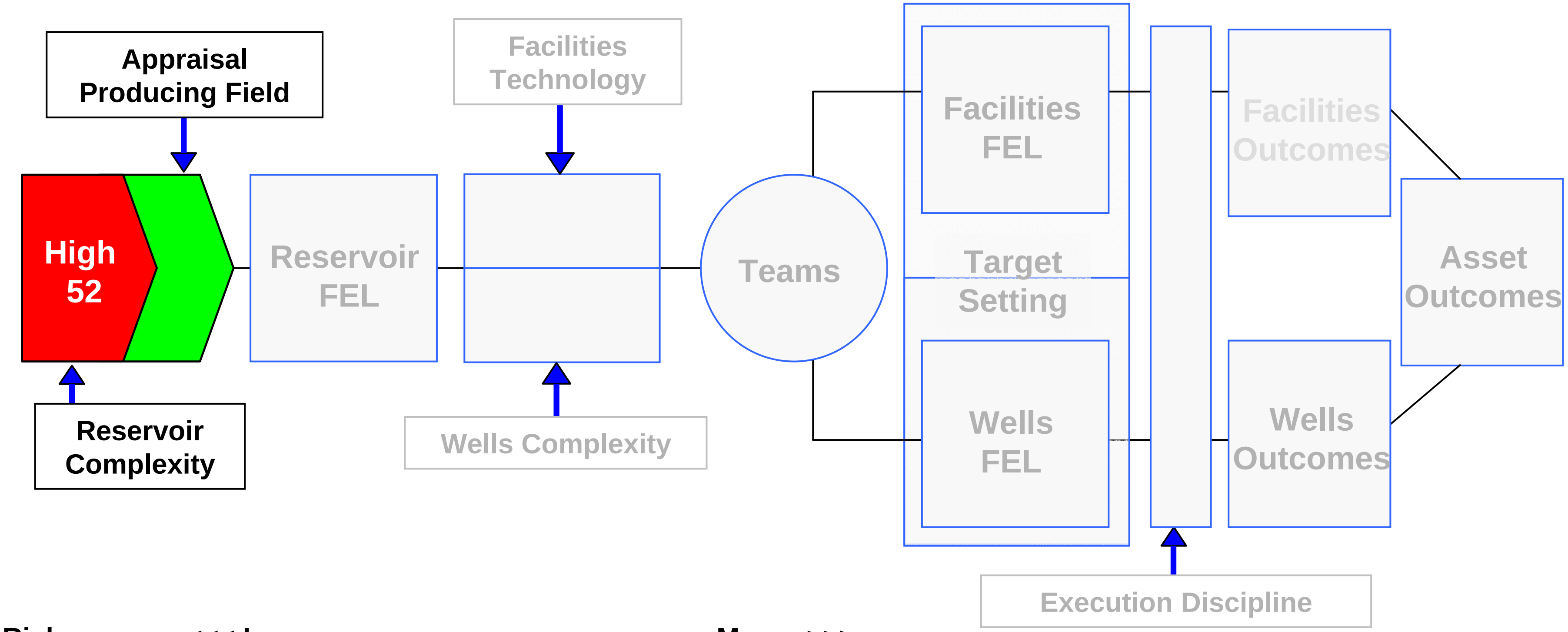
Basis of Comparison
Well Construction

Characteristic	Samarang Phase 1	Samarang Phase 2	Dataset (297 projects)		
			Minimum	Median	Maximum
Year of Authorisation	2010	2011	1990	2001	2008
Actual Wells Cost ($\text{US\$}^{MOD}$ million)	94 (estimated)	309 (estimated)	10	372	> 9,310
Region	Malaysia	Malaysia	North America, 21%; Europe, 35%; Africa, 12%; South America, 14%; Oceania, 8%; Asia, 10%		
Water Depth (m)	10-50	10-50	3	137	2,658
Post Startup Life-of-Project Production Stream (MMBOE)	14 (estimated)	62 (estimated)	2	102	3,287

Outline

- **Key Message**
- **Project Background**
- **Basis of Comparison**
- ***Practices and Drivers – Phase 1***
- **Targeted Outcomes**
- **Conclusions**
- **Recommendations**

Drivers of Project Success
Reservoir Complexity

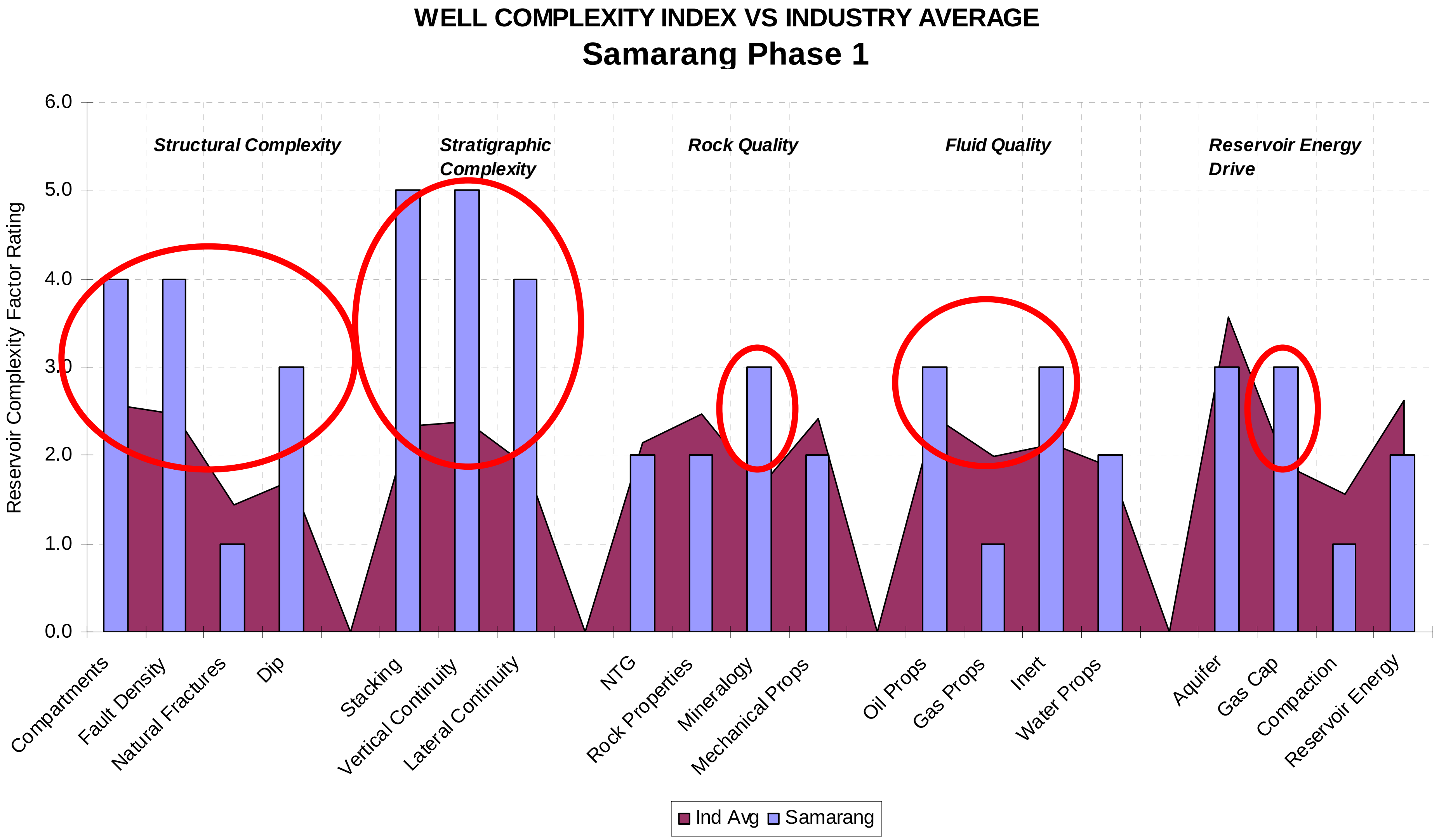


Risk	<<< Less	--------	More >>>
Results	<<< Better	--------	Worse >>>

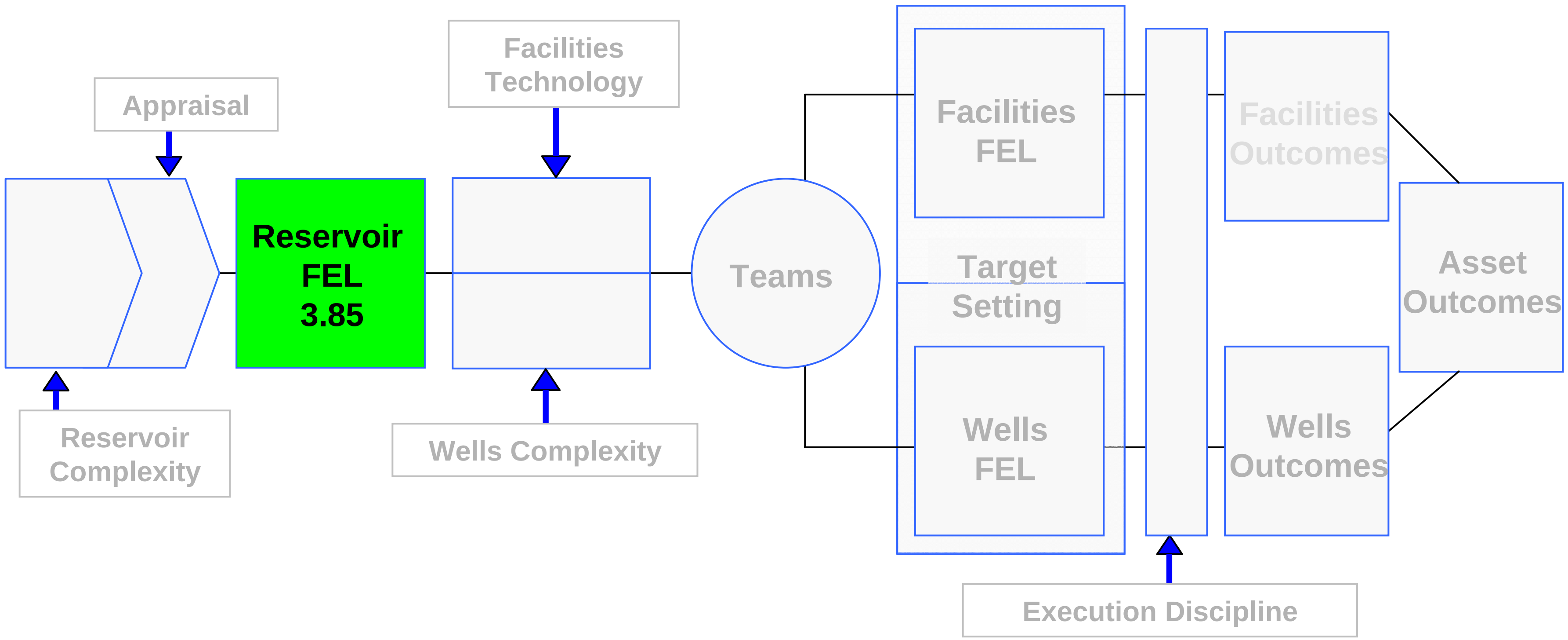
Low	Medium	High

APPRAISE — GATE — SELECT — GATE — DEFINE — GATE — EXECUTE — GATE — OPERATE

Samarang Fields' Reservoir Complexity
Highly Complex Reservoir Influences Development



Drivers of Project Success
Reservoir FEL



Risk **<<< Less** **--------** **More >>>**

Results **<<< Better** **--------** **Worse >>>**

Low	Medium	High

APPRAISE | GATE | **SELECT** | GATE | **DEFINE** | GATE | **EXECUTE** | GATE | **OPERATE**

Reservoir Front-End Loading

Inputs

- Seismic
- Logs
- Cores/SCAL
- Fluid Properties
- Well & Reservoir Tests
- Pressures
- Production History Analogs

Constraints

- Regulatory/ Environmental
- Timing
- Budget
- Appraisal Strategy
- Operating Constraints
- Technology/Tolerance for Risk
- Business Commercial Strategy Issues
- Joint Operating Agreement Issues

Tasks

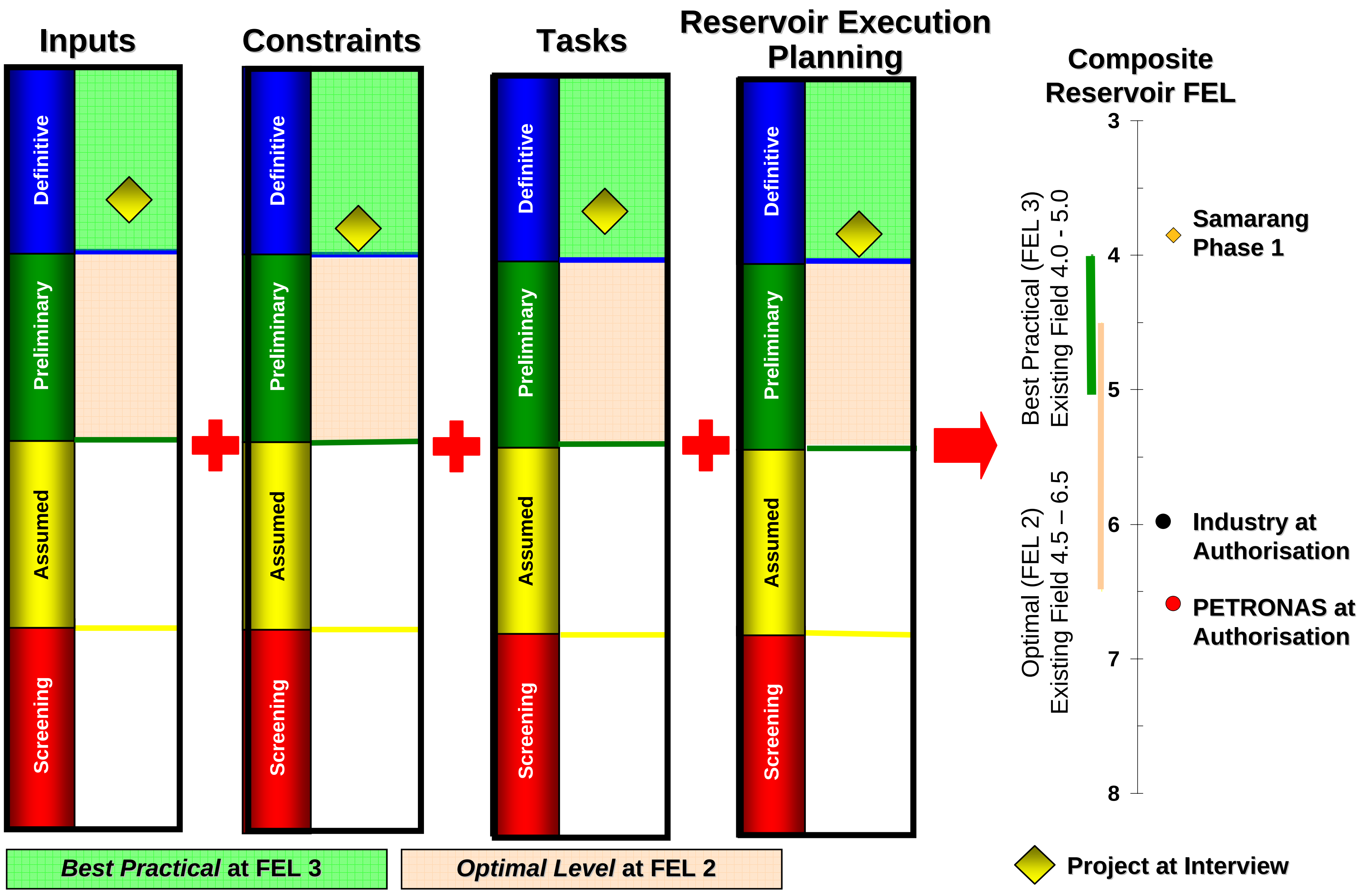
- Interpret Seismic
- Develop Maps and Geologic Model
- Integrate Wells Team
- Characterise Fluids
- Complete Reservoir Design Basis
- Understand Drive Mechanism
- Define Compartments
- Predict Production Profiles and Reserves
- Complete Risk and Uncertainty Analysis

Execution Planning

- Subsurface Team Interactions
- Schedule Development
- Plans/Documents Completed
- Controls in Place

Reservoir FEL by Component

Best Practical for Phase 1 at Authorisation



Reservoir FEL Status (1)
Samarang Project Phase 1

Inputs – *Definitive* (*Best Practical* rating)

- Field has been producing for 30 years with 140+ wells
- Logs, pressure, and fluid data were received
- Cores taken in 1970s but sample deteriorated over time
  - Plans to take a full core sample during Phase 1 drilling program
    - To gather information on deeper sand characteristics for EOR scope in Phase 2
- No injectivity test is required for Phase 1

Reservoir FEL Status (2)
Samarang Project Phase 1

Constraints – *Definitive* (*Best Practical* rating)

- **Strategic alliance contract in negotiation for over 12 months**
  - **Driving delays in approvals, including OCS* – OCS was approved on 22 February 2010**
  - **Alliance contract expected to be signed on 23 March 2010**
- **New core information required to assist in EOR development for Phase 2**
  - **Major constraint to team in 2009 when PETRONAS had not approved of further appraisal data for EOR purposes**
  - **PETRONAS has since given approval for core and to collect more data**

*** OCS – Overall Contracting Strategy**

Reservoir FEL Status (3)

Samarang Project Phase 1

Tasks – *Definitive* (*Best Practical* rating)

- **All seismic activities completed, with 3D simulations**
- **Plans to obtain cores and further analysis for EOR scope and optimisation of Phase 2 wells scope**
- **Drive mechanisms understood, production profile peer reviewed, and 3D models defined for field**
- **Well locations defined; team decided not to perform slot recovery**
  - **slot recovery not in scope but is contingency plan if wells do not perform**
- **Risk and certainties analysis done and mitigation plan in place for execution**

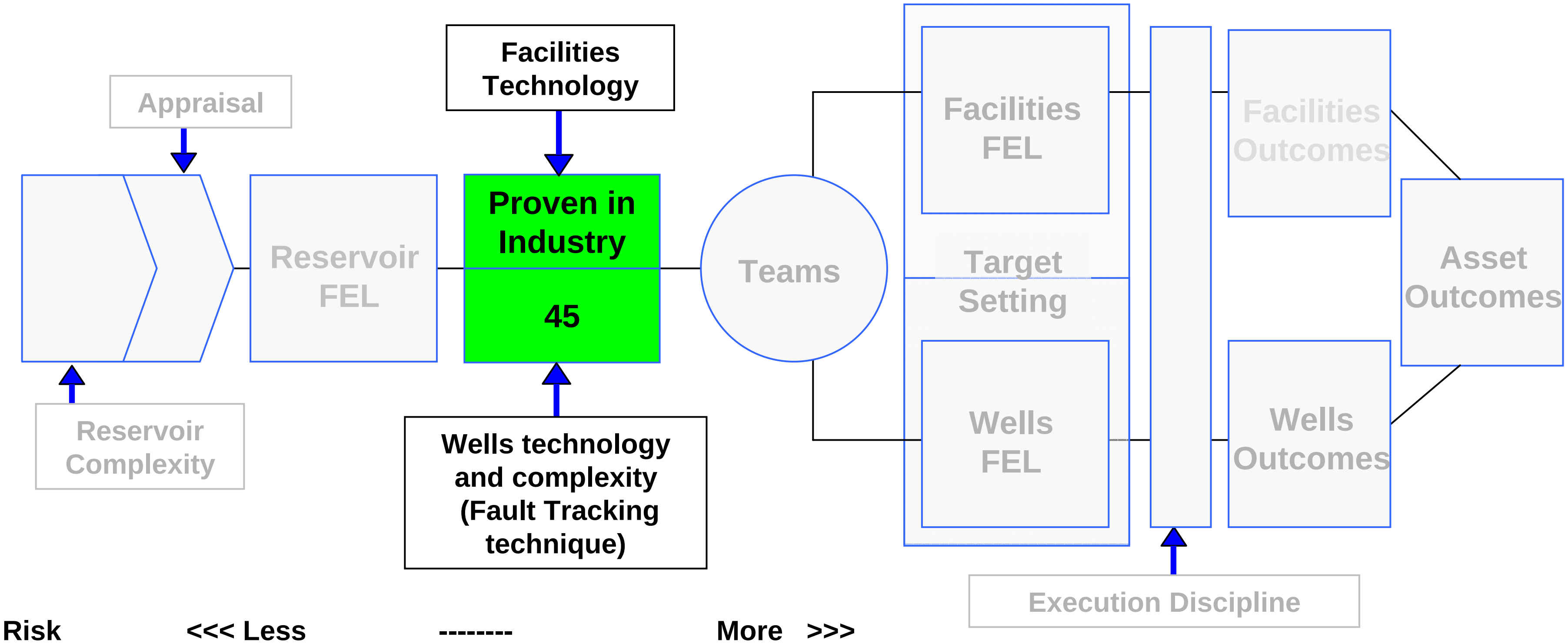
Reservoir FEL Status (4)
Samarang Project Phase 1

Execution Planning – *Definitive* (*Best Practical* rating)

- **Dedicated reservoir engineer, geologist, and geophysicist assigned to team since early project stage**
  - **Roles remain on team to date; team will roll over to Phase 2 once Phase 1 is near complete**
- **Roles and responsibilities defined and understood by core team**
  - **Subsurface mainly consists of Schlumberger staff but well integrated with PCSB team**
- **High level integrated subsurface schedule developed**
- **Preliminary Basis of Memorandum, Integrated Reservoir Management Plan, and Field Development Plan (FDP) prepared**

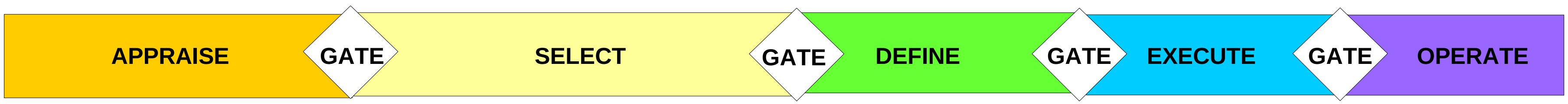
Drivers of Project Success

Facilities and Wells Complexity



Risk	**<<< Less**	**--------**	**More >>>**
Results	**<<< Better**	**--------**	**Worse >>>**

Low	Medium	High



Well Complexity Index
Phase 1 Lower Than Industry

Samarang Phase 1 well designs less complex than Industry, except:

- Multi-zone gravel-packs, and high number of completion kits drive complexity

Complexity Category	Samarang Oil Producers	Industry Average
Subsurface Hazards	6	15
Reservoir Interface	20	16
Well Geometry	9	11
Rig Equipment	5	11
Environmental and Meteorological Conditions	4	6
Total Well Complexity Index	45	59

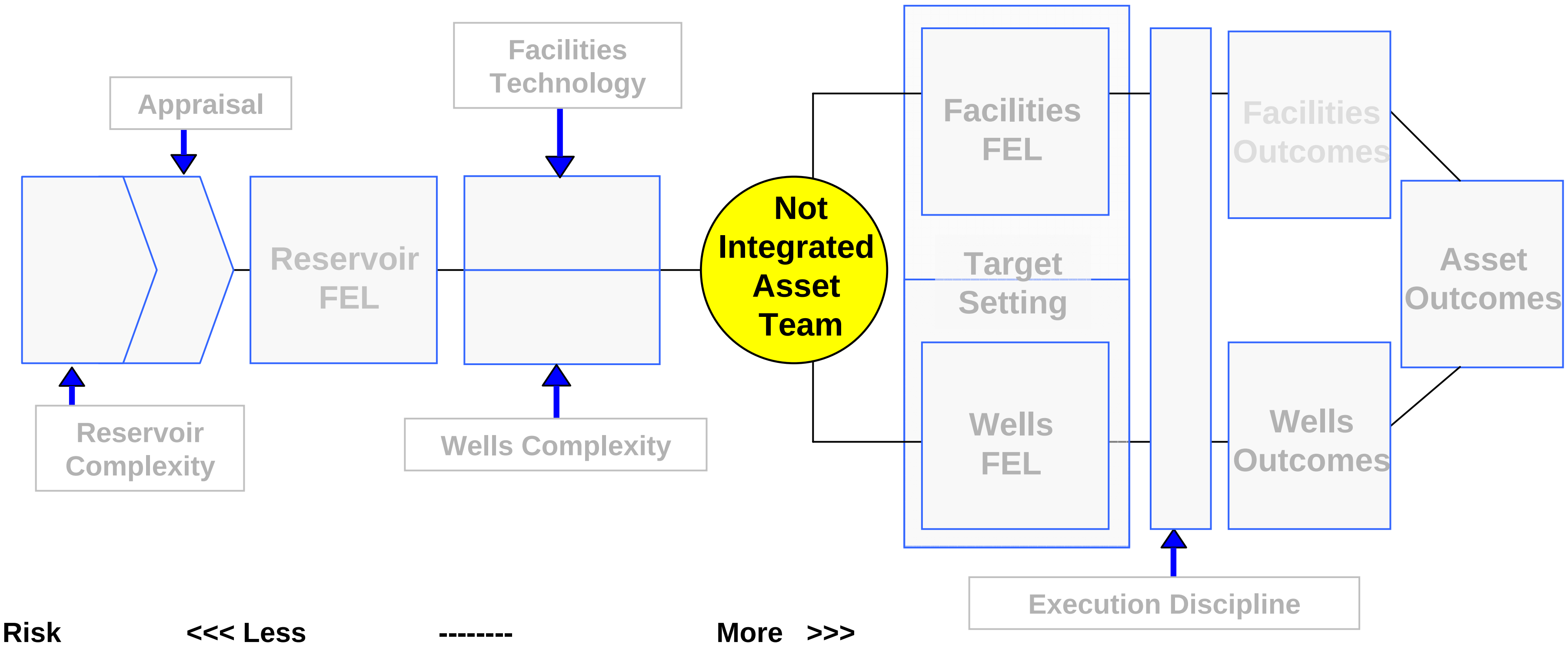
Facilities Technology
Samarang Project Phase 1

Conventional technology

- **Platforms**
  - **Conventional wellhead designs**
  - **Process controls will be based on current design on Samarang**
- **Team is familiar with current technology**

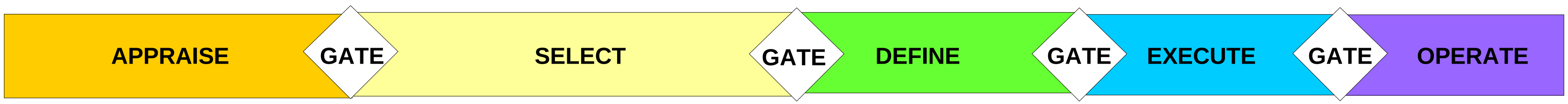
Drivers of Project Success

Integrated Asset Team Lacking



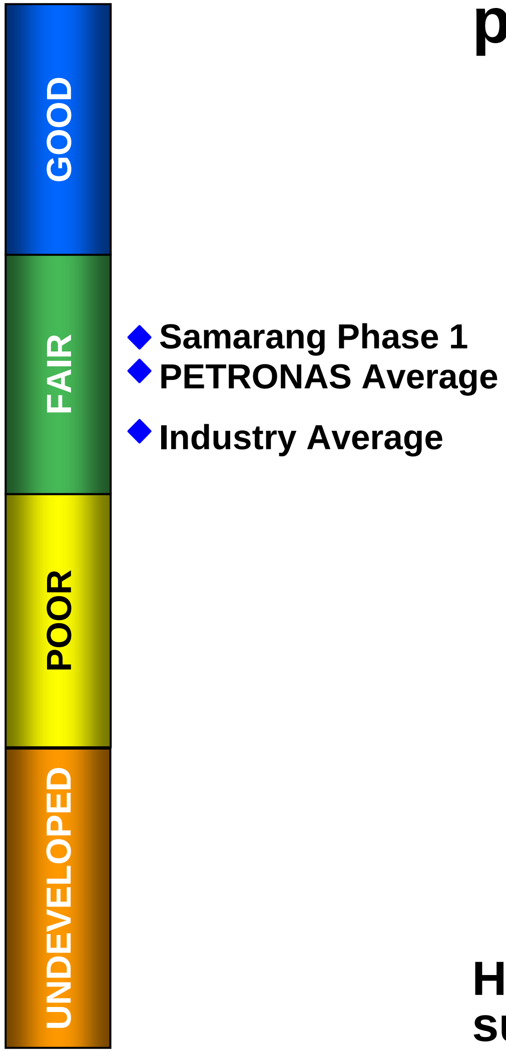
Risk	<<< Less	--------	More >>>
Results	<<< Better	--------	Worse >>>

Low | Medium | High



Team Development Index (TDI)

Saramang Phase 1 TDI Is Fair



Samarang Phase 1 has fulfilled most team practices:

- ☑ ***Project objectives defined, understood, and agreed to*** **Phase 1 objectives are aligned with business objectives and are understood by project team**
- ☒ ***Operations representative lacking:*** **Team receives inputs from offshore operations team but lacks a dedicated operations representative**
- ☑ ***Team roles and responsibilities defined, understood, and agreed to***
- ☑ ***Major tasks and problems identified and planned for (typically using a risk assessment)*** **A risk register has been set up for use by various functions; major tasks and issues were identified and monitored, mitigation plans are in place**
- ☑ ***PETRONAS Project Management System process is followed***

However, PCSB management wants to relocate part of the subsurface and wells team, creating interface and communication risks within the team

Samarang Missing Critical Team Members

- Four key team positions drive megaproject excellence
- Significant difference between success and failure when these key owner positions are filled:
  - ☑ Project Manager (PM)[1]
  - ☒ Appropriate Operations Representation[2]
  - ☑ Project Control Specialists
  - ☑ Owner Schedulers
  - ☑ Contract Specialists
- When all positions were filled: 75% were successful
- When they were not all filled: 30% were successful

Note:

1. A PM is a critical team member, but we do not see megaprojects without a PM, therefore we cannot see a statistically significant difference in project success regarding this team member
2. Samarang Project plans to recruit an Operations Representative as a full time basis during Define Phase

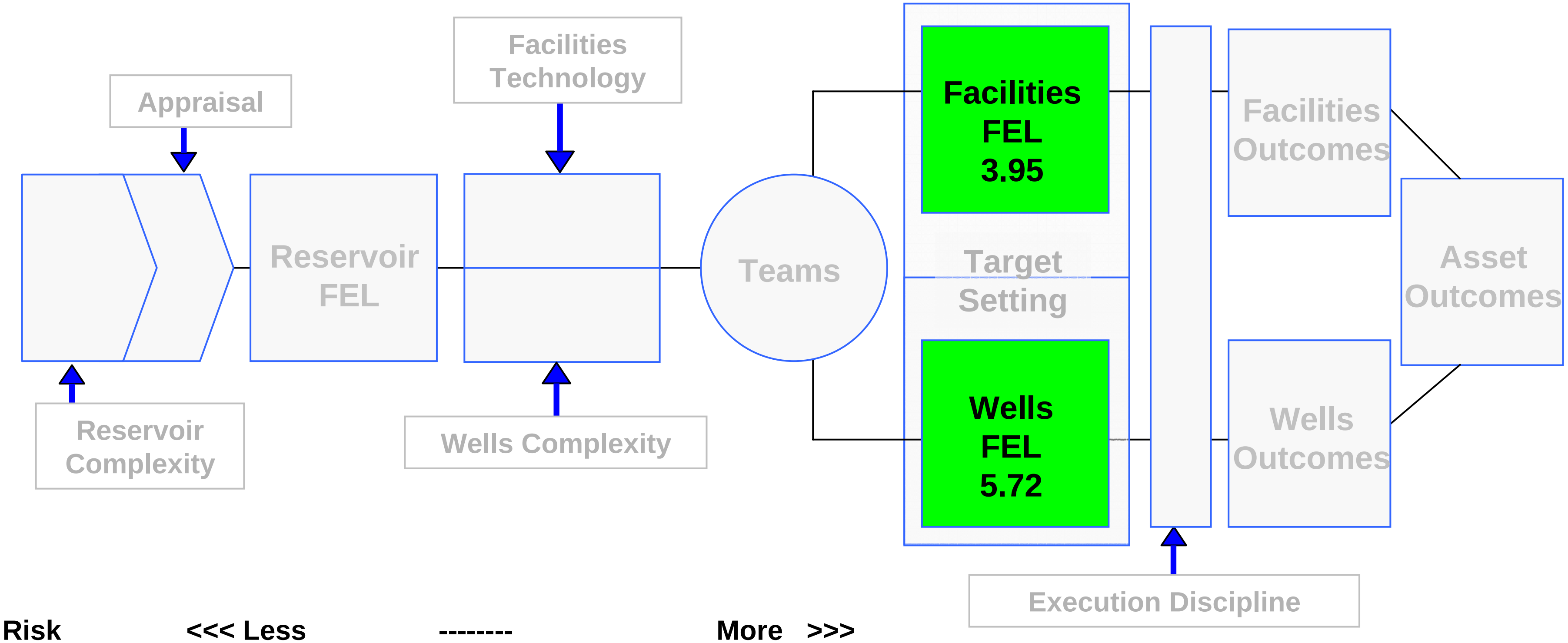
Operations Representative

- ✓ Have first-hand knowledge of facility (or like-facilities)
- ✓ Input is critical for engineering definition
- ✓ Input reduces occurrence of late design changes
- ✓ Have specific knowledge around feedstock and operating conditions
- ✓ Have expertise to review design

Source: IPA Institute Course: Megaprojects

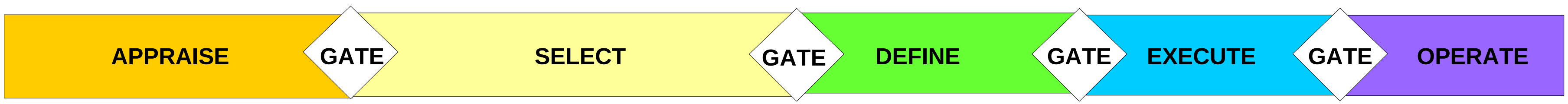
Drivers of Project Success

Facilities FEL and Wells FEL



Risk	**<<< Less**	**--------**	**More >>>**
Results	**<<< Better**	**--------**	**Worse >>>**

Low	Medium	High



Well Construction Front-End Loading

Scope of Work

- Offset Wells
- Commercial
- Well Objectives
- Scope of Work
- Location Survey
- Metocean Data
- All Needed Technical Inputs

Regulatory HSE

- Permitting
- Preliminary Safety Management Plan
- Hazid Analysis
- Company Policies
- Waste Management

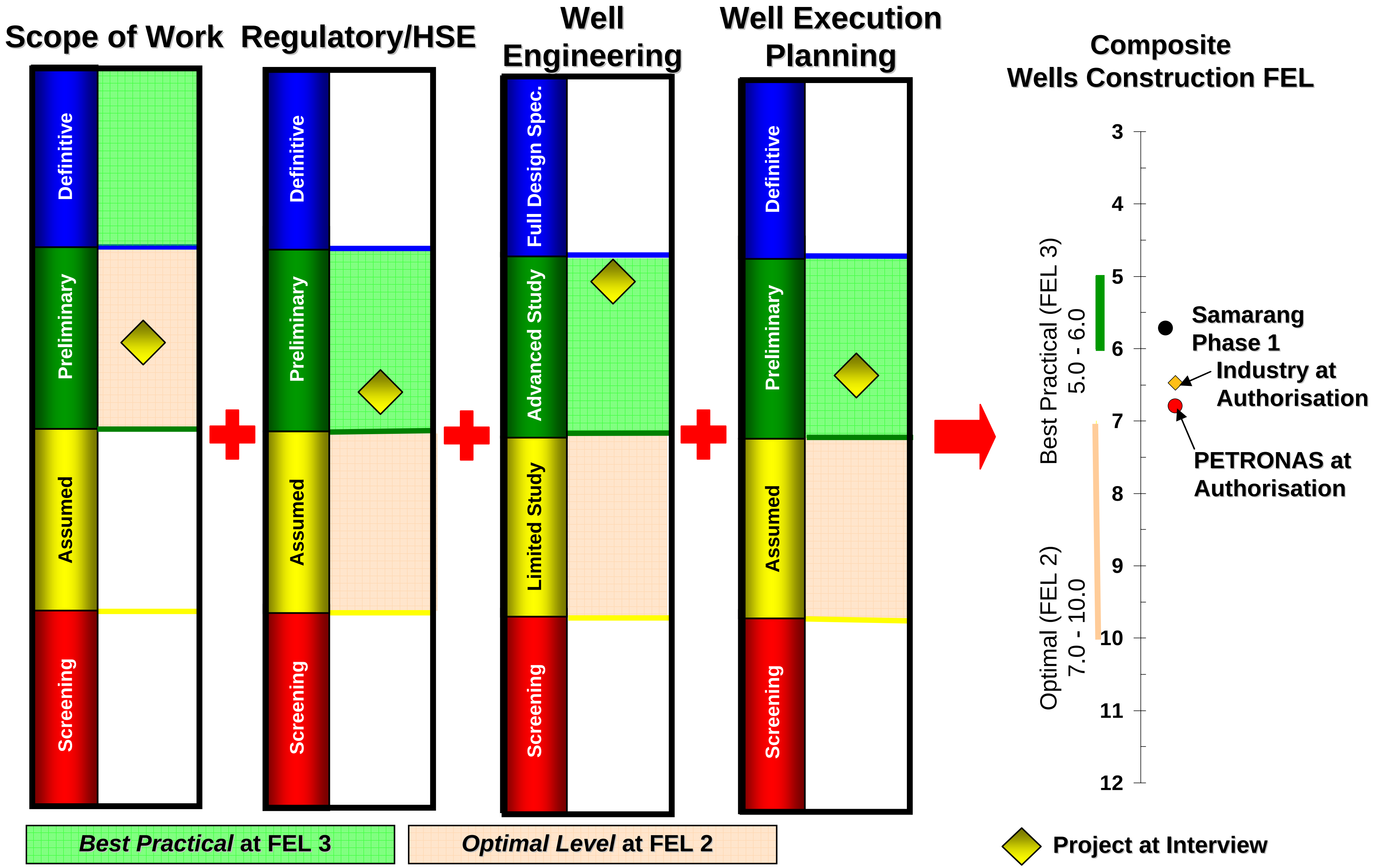
Well Engineering

- Casing Design
- Completion and Stimulation Plans
- Certify Rig
- Certify Equipment
- Long-Lead Items Identification
- Scenario and Option Planning
- Peer Review
- Stakeholder Buy-in

Execution Planning

- Contracting Strategy
- Team Composition
- Procurement Plan
- Secured Rig
- Logistics
- Schedule Estimate including concurrent ops, SIMOPs, etc.
- Detailed Well Plan to Achieve Objectives
- Program Cost Estimate

Well Construction FEL by Component
Best Practical for Phase 1 at Authorisation



Wells FEL Status (1)

Samarang Project Phase 1

Scope of Work – *Preliminary* (*Best Practical* is *Definitive*)

- **Team has good understanding of environment in Samarang**
  - **However, soil and seabed strength of jack-up rig location not yet investigated**
    - > **Plans to conduct soil boring in March 2010**
- **Drilling program objectives developed and confirmed with business group**
- **Drilling plan being prepared as part of FDP**

Wells FEL Status (2)

Samarang Project Phase 1

Regulatory/HSE – *Preliminary* (*Best Practical* rating)

- **Permit requirement for drilling activities identified**
- **HSE management plan will be similar to current operations, as drilling activities are ongoing within PCSB**
- **Safety assessment review not conducted to date, but drilling team has reviewed and provided inputs to facilities team on rig move and platform related operations**
- **Permission obtained from government to dump water based mud to sea**

Wells FEL Status (3)

Samarang Project Phase 1

Planning – *Preliminary* (*Best Practical* rating)

- **Core team in place, including completion team**
- **Drilling services and tubular contracts in place**
- **Trident-16 rig contracted for Phase 1**
- **SIMOPS developed with operations**
- **Individual well AFEs* developed but will be revised once wells design is optimised before authorisation**

*** AFE – Approved For Expenditure**

Wells FEL Status (4)

Samarang Project Phase 1

Engineering – *Advanced Study* (*Best Practical* rating)

- **Surface and bottomhole locations confirmed**
- **Preliminary drilling equipment list completed**
- **Team has well designs completed for each well, not yet approved by PCSB management**
  - **Wells design being optimised before authorisation**
- **Fault tracking drilling technique being further developed**
  - **Seismic information on fault not clearly identified**
  - **Further studies required to understand location of faults; team using offset logs and seismic to find location**

Wells FEL Status (5)
Samarang Project Phase 1

Engineering – *Advanced Study* (*Best Practical* rating) cont'd

- **Well bore stability study done in 2009**
  - **Per study, gravel packing for K layer not required (unlike current designs), hence sand removal facilities are not required**
  - **If study is incorrect, K sand will be a producing sand without proper sand mitigation – contingencies not in place for this scenario**

Facilities Front-End Loading

Project Specific Factors

- Soils and Surveying
- Permit Requirements
- Concession Terms
- Import/Export Terms
- Community Relations
- Security
- Offshore Persons on Board Requirements
- Support and Logistics
- Local Content
- Local Labour
- HSE for Operations
- HSE for Fabrication, Transport, and Installation
- Yard Availability

Execution Planning

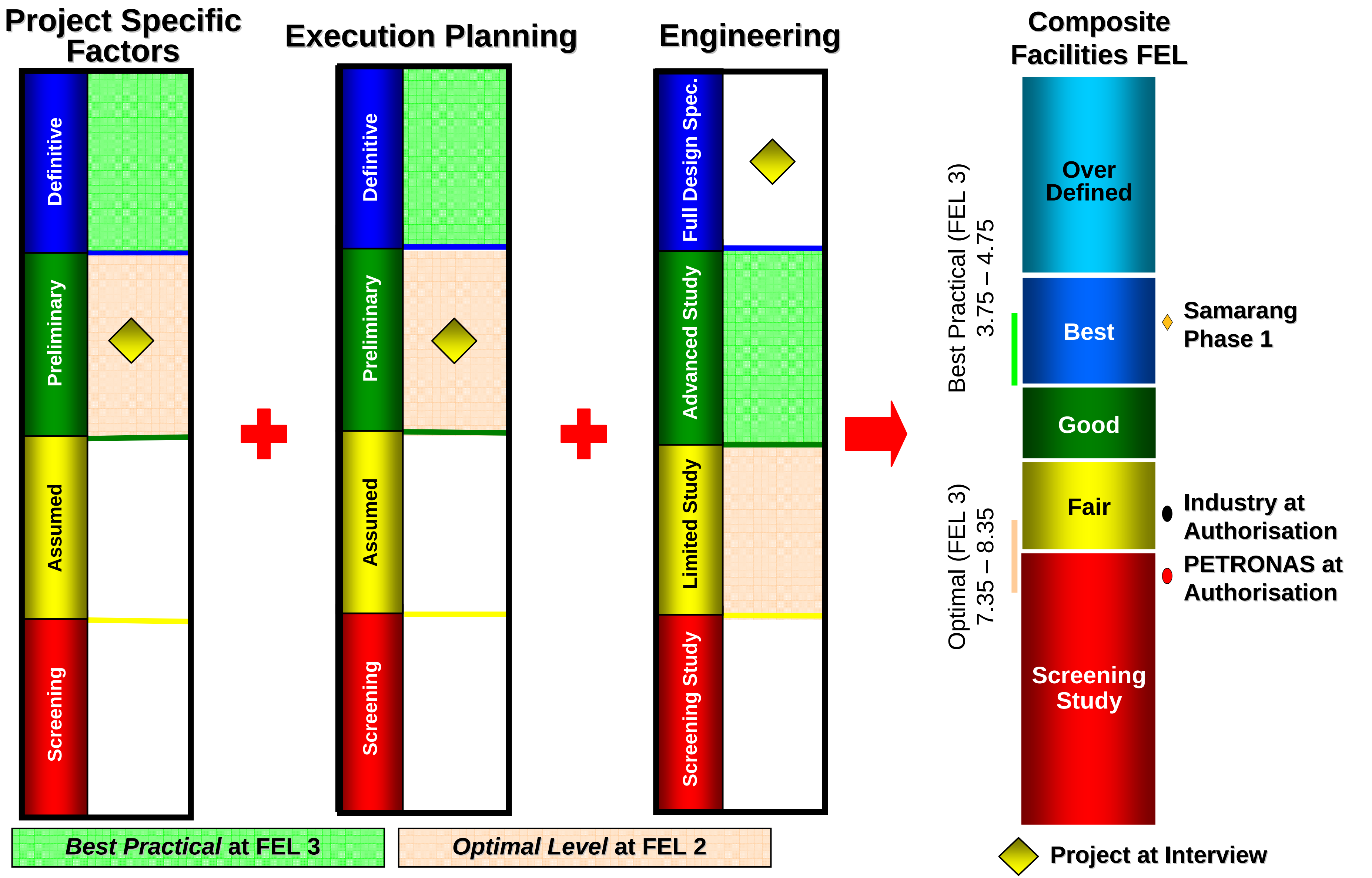
- Contracting strategy
- Team participants & roles
- Integrated schedule
  - Critical-path items
  - Identification of shut-down for tie-ins
  - Resources
  - Overtime
- Plans
  - Commissioning
  - Startup
  - Operation
  - Well construction
  - Quality assurance
- Cost and schedule controls

Engineering

- Engineering tasks
  - Fluid Definition
  - Detailed scope
  - PFDs
  - H&MBs
  - Preliminary P&IDs
  - One-line elec. diagrams
  - Major equipment specifications
  - Cost estimate
- Participation/buy-in of:
  - Operations
  - Maintenance
  - Business
  - Subsurface

Offshore Facility FEL by Component

Phase 1 is Best Practical at FEL 3



Facilities FEL Status (1)

Samarang Project Phase 1

Project Specific Factors – *Preliminary* (*Best Practical is Definitive*)

- **Soils, metocean, and surveying data available**
- **Local labour supply generally understood**
- **Local content known and understood**
- **HAZOP review completed in detailed engineering**
- **Allowable POB on platforms assumed based on previous projects**
- **Floatel/crane barge identified and locked-in via existing PCSB contracts**

Facilities FEL Status (2)

Samarang Project Phase 1

Execution Planning – *Preliminary* (*Best Practical* is *Definitive*)

- **Team organisation chart defines team structure and positions with documented roles and responsibilities**
- **Comprehensive PEP prepared covering both phases (1 & 2), but more emphasis and details placed on Phase 1**
  - **PEP covers quality management, HSE, communication management, risks, project controls, procurement, drilling, HUC, and commissioning**
    - **However, logistics section lacks detail, with material coordinator not appointed**

Facilities FEL Status (3)
Samarang Project Phase 1

Execution Planning – *Preliminary* (*Best Practical* is *Definitive*) cont'd

- **Phase 1 schedule prepared**
  - **Offshore revamp scope lacks details**
  - **Assumed allowable POB* on platforms during HUC scope not yet confirmed with operations**
  - **Detailed manpower plans not developed for offshore revamp scope; feasibility of completing scope on schedule not studied**
  - **Does not account for possible barge move between SMJT-F and SMDP-B**

***POB – Personnel On Board**

Facilities FEL Status (4)
Samarang Project Phase 1

Execution Planning – *Preliminary* (*Best Practical* is *Definitive*) cont'd

- **Issued HUC contract bid documents based on site-assembled deck extensions on platforms**
  - **However, team planning to change strategy to modular lift using PCSB's barge crane/floatel**
  - **HUC bidders not informed and team expects them to accept change in barge crane/floatel strategy immediately after award—poses risk of late change**
  - **Team also facing risk of late approval of HUC contract due to historically slow approval process for large award packages**

Facilities FEL Status (5)
Samarang Project Phase 1

Engineering – *Full Design Specification* (*Overdefined*)

- **PFDs and P&IDs completed and reviewed by site-based operations team**
- **Detailed structural weight calculations performed for deck extensions**
- **All engineering drawings, including piping isometrics and structural drawings, approved for construction**
- **Detailed cost estimate developed; based on recently completed projects**

Asset FEL Components

Reservoir FEL + Facilities FEL + Wells FEL → Asset FEL

Reservoir FEL

- Inputs
- Constraints
- Tasks
- Planning

Facilities FEL

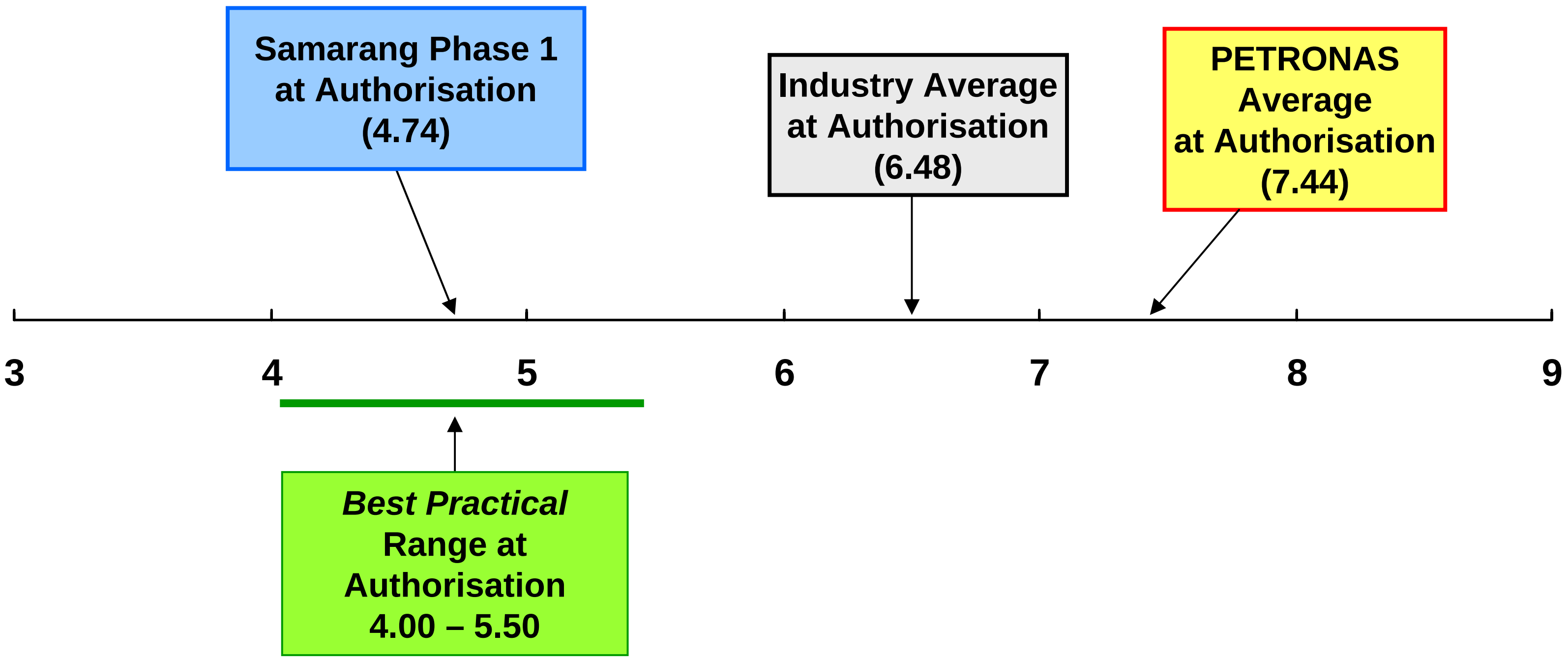
- Site Factors
- Engineering
- Planning

Wells FEL

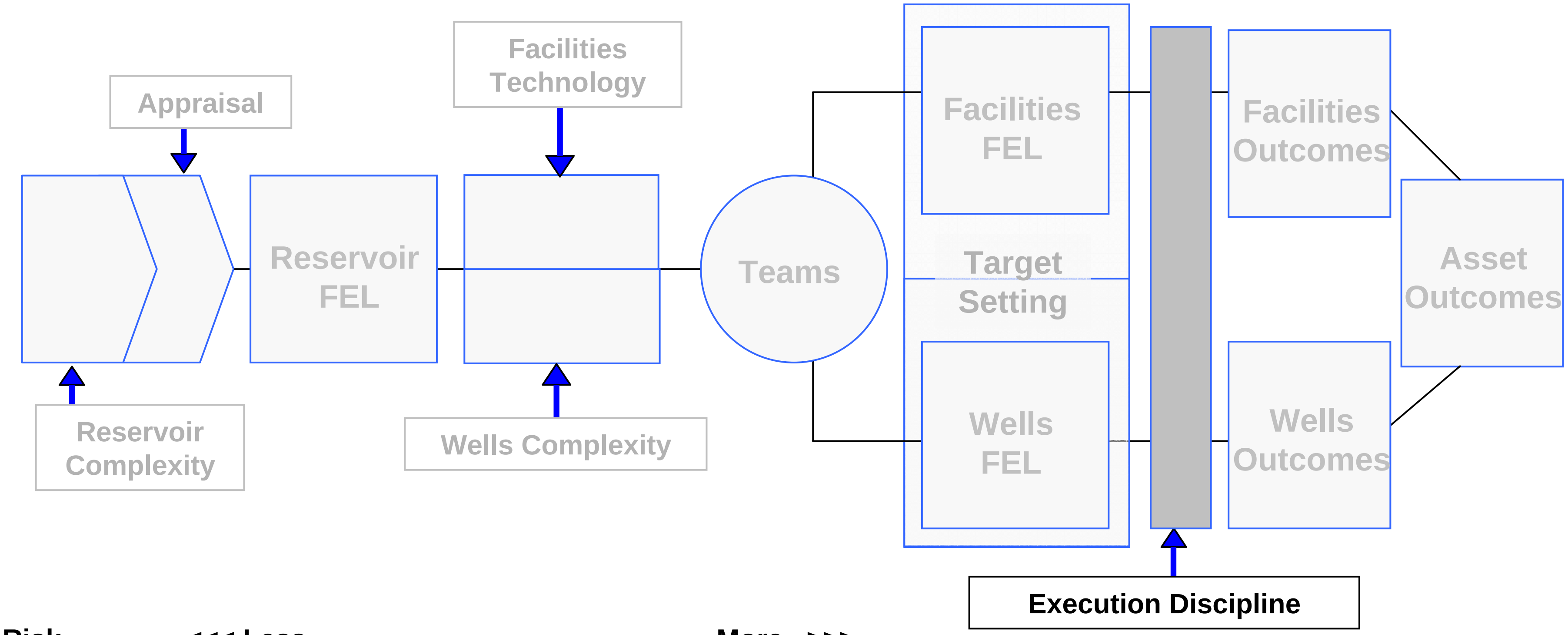
- Scope of Work
- Regulatory
- Engineering
- Planning

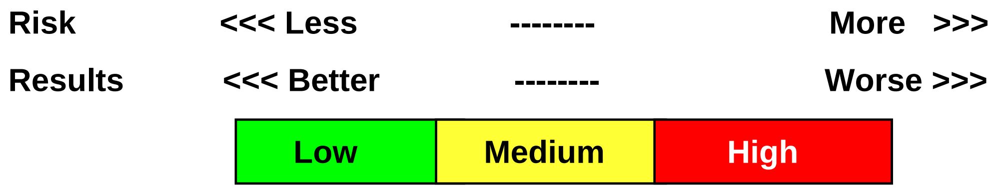
Asset FEL

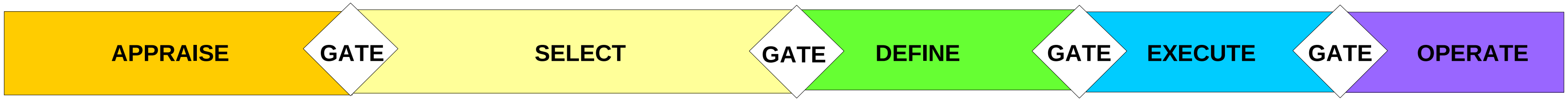
Samarang Phase 1 in Best Practical Range at Authorisation



Pathway to E&P Project Success
Execution Discipline







Samarang Phase 1 Execution Discipline
Risk of Late Design Changes

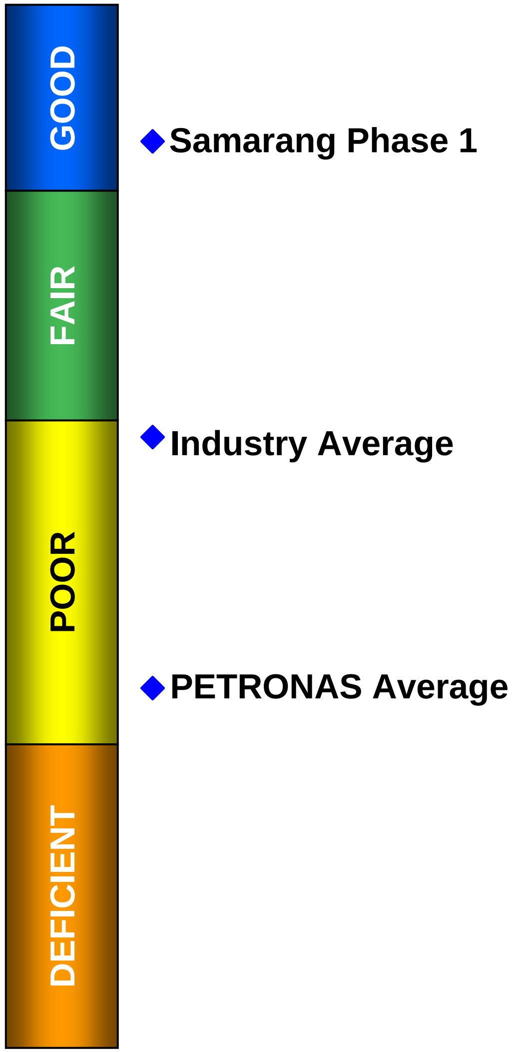
- **Based on PETRONAS' history, Phase 1 faces a high probability of late changes**

Project Execution Discipline	**Samarang Phase 1**	**Industry Average**	**PETRONAS Average**
Planned Project Control Index (PCI)	*Good*	*Poor*	*Poor*
Project Manager Turnover	Not Applicable	39 percent of projects	35 percent of projects
Major Late Design Changes	Not Applicable	22 percent of projects	100 percent of projects*

***Majority of PCSB projects were authorised using the previous Project Management System – at end of Select phase**

Project Control Index

Planned PCI for Phase 1 Is On Track



☑ ***Project estimate quantitatively validated by owner*** **– Cost estimate will be reviewed by PCSB peers**

☑ ***Physical progressing*** **– Physical progressing planned at summary level, will be further developed by HUC contractor**

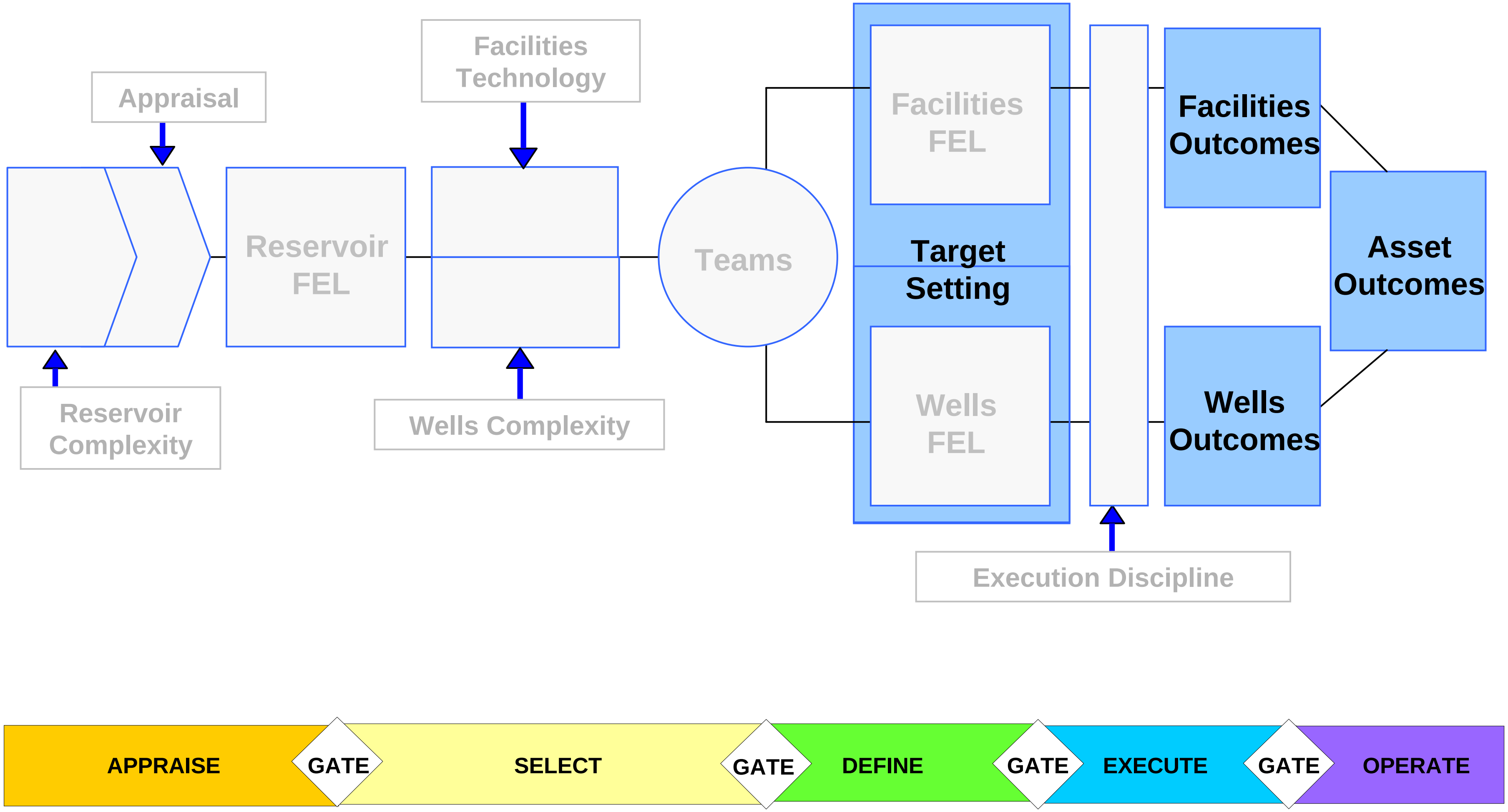
☑ ***Planned level of detail and frequency of progress reporting*** **– Plans to issue detailed reports biweekly**

☑ ***Assigned project control specialist*** **–Dedicated cost controller/planner on team**

Outline

- **Key Message**
- **Project Background**
- **Basis of Comparison**
- **Practices and Drivers**
- ***Targeted Outcomes – Phase 1***
- **Conclusions**
- **Recommendations**

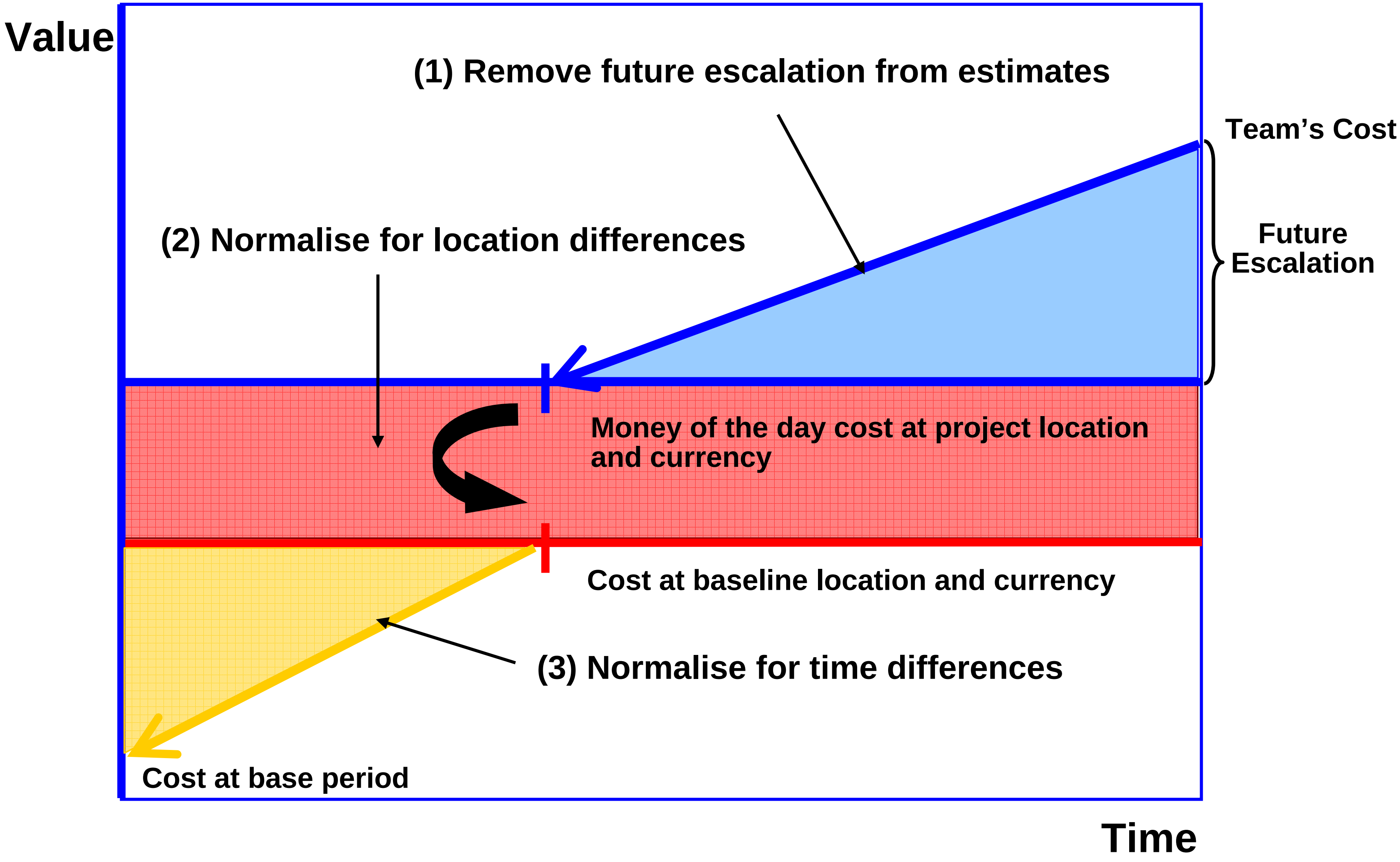
Pathway to Asset Success
Planned Outcomes



Cost Estimate Adjustment Methodology

- Using provided cost breakdowns, IPA adjusts line by line
  - Foreign exchange is done using monthly average exchange rate to U.S. dollars
  - Costs are de-escalated to constant date using previously discussed indices
- Estimates are adjusted based on date of estimate
- IPA assumes:
  - Prices reflect estimate date
  - Escalation is broken out
  - Contingency is broken out
- When contingency and escalation are buried in line items, IPA adjustments and benchmarks are not as accurate

How Does IPA Normalize Costs?
Three Steps



Samarang Phase 1 Cost Breakdown

Description	Facility	Drilling	Total
Front-End Engineering	Not Provided		0.00
Detailed Engineering	3.92		3.92
Project Management	11.15	10.01	21.16
Fabrication	4.63	2.47	7.10
Installation	17.38		17.38
Non-wells activities		4.55	4.55
Drilling		27.46	27.46
Formation Evaluation		2.77	2.77
Completions		35.92	35.92
Hook-up and Commissioning	2.14		2.14
Other Project Costs	0.27	0.07	0.34
Contingency	0.00	10.09	10.09
TOTAL PROJECT COSTS	39.49	93.34	132.83

Statistical Models

- Based on historical performance of past projects
- Used to generate industry benchmark for projects with similar characteristics
- Used to provide statistical range around industry averages
- Used to measure individual project's actual/planned outcomes versus industry average

Cost Analysis
What Does Each Level of Cost Analysis Tell You?

- **Development Cost Competitiveness ($/BOE) – What would Industry spend, on average, to develop a prospect with comparable resource promise, water depth, and region?**
- **Component Cost Competitiveness – What would Industry spend, on average, to execute each facility or well construction program, <u>as designed by you?</u>**
- **Gap and UCEC[1] Analysis – Comparison of cost line items with similar projects**

Note:
1. UCEC is the Upstream Cost Engineering Committee

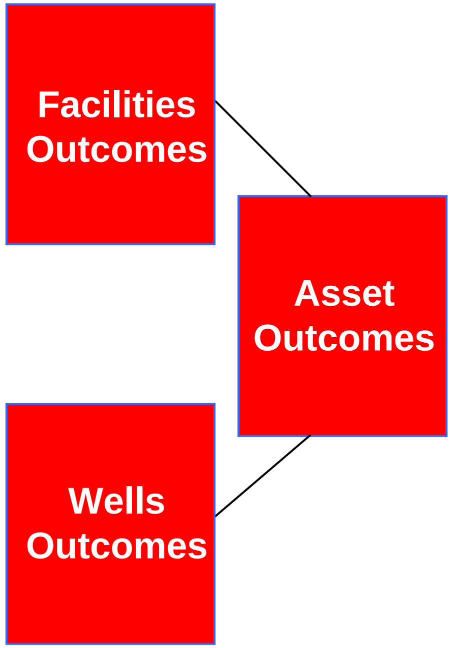
Pathway to E&P Project Success
Metrics Applicable to Samarang Phase 1

$/BOE Asset Development Effectiveness

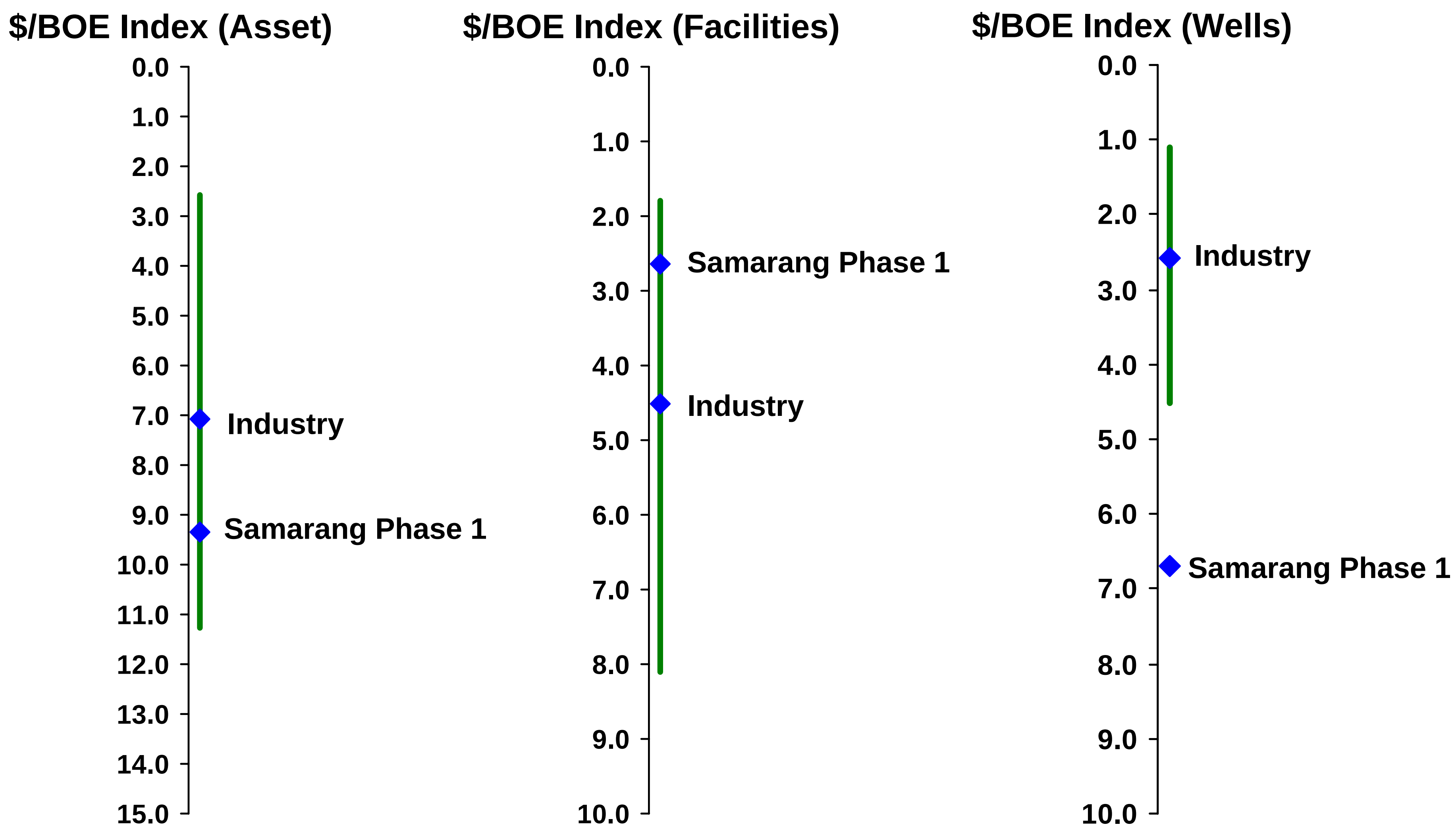
– **$/BOE for facilities and well program**

Individual Component Benchmarks

– **Wells program competitiveness (as designed)**



Phase 1 Cost Competitiveness Analysis
$/BOE for Wells Are Uncompetitive



Note:

1. The solid bar line represents the industry ranges normalised for BOE and water depth

Cost Analysis – $/BOE

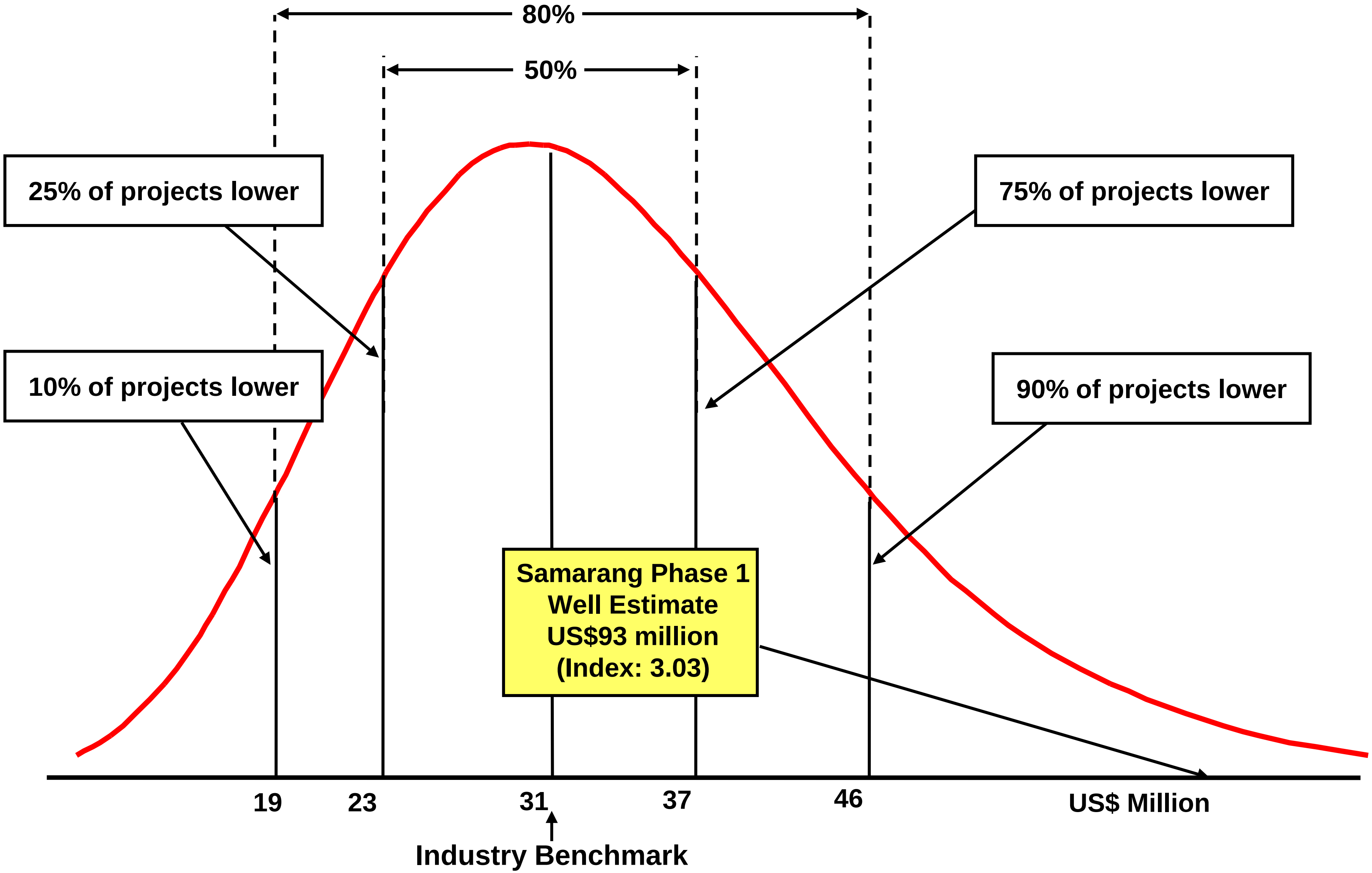
Wells $/BOE Driving Uncompetitive Targets

- **Asset $/BOE is more expensive than Industry, driven by high $/BOE for wells portion**
- **Uncompetitive drilling $/BOE driven by low resource promise/well**
  - **2.8 MMBOE/well vs. dataset average of 9.2 MMBOE/well**
- **Competitive facilities $/BOE driven by low cost of revamp scope platforms for planned resource promise**

Note:
[1] **Comparison dataset consists of 7 projects with 25 wells in the wells program. 3 of the projects in the set are in Asia Pacific.**

Well Construction Component Model

Phase 1 Cost Is Much Higher Than Industry



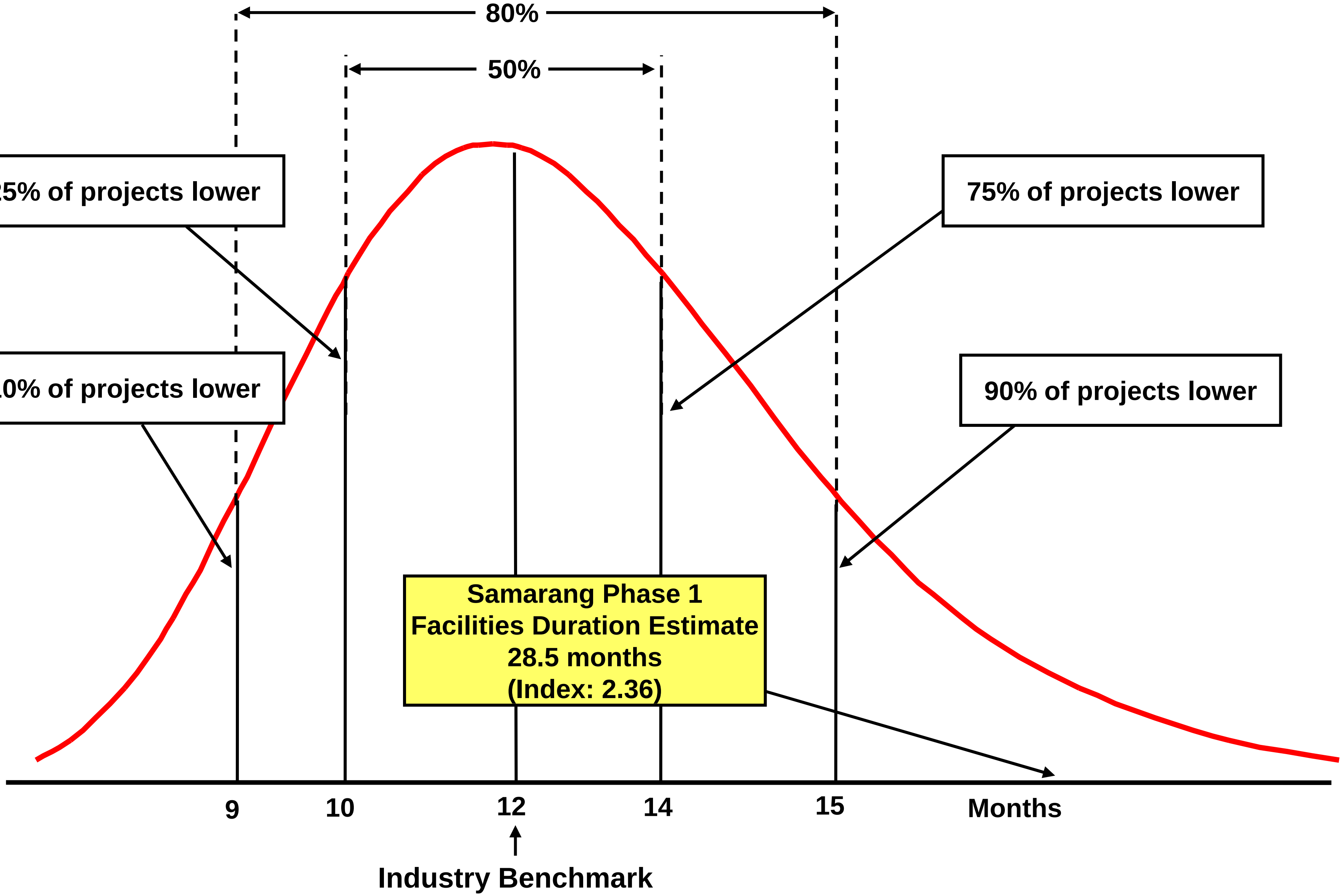
Cost Analysis
Wells Construction

Phase 1 drilling program more expensive than Industry

- **Drilling rig rates are higher than Industry (normalising for rates only accounts for US$4 million)**
- **Phase 1 wells cost per well is US$18.8 million vs. US$13.0 million per well for comparison dataset with similar well complexity**
- **Multi-zone gravel packs is estimated to be US$30 million more than single screen completions**

Note:
[1] **Comparison dataset consists of 7 projects with 25 wells in the wells program. 3 of the projects in the set are in Asia Pacific.**

Facilities Execution Duration Model
Phase 1 Significantly Slower Than Industry



Facilities Execution Schedule Analysis
Samarang Project Phase 1

Facilities' CAPEX (US$ million)	Detailed Engineering Start Date	FID Date	Mechanical Completion Date	Samarang Phase 1 Execution Duration (Months)	Industry Average (Months)	Top Quartile (Months)
37	June 2009	April 2010	October 2011	29	12	10

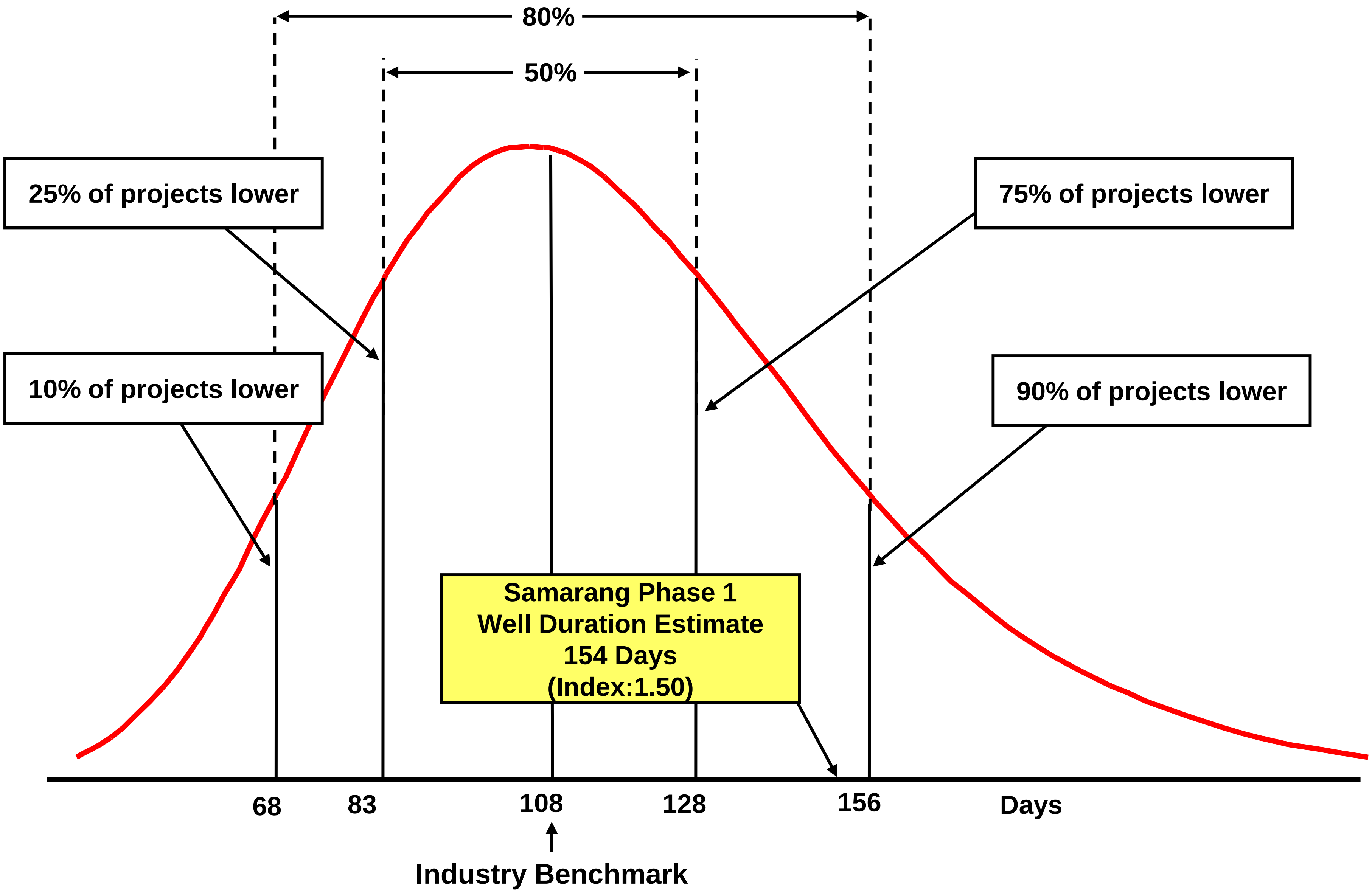
- **Phase 1 started detailed engineering prior to FID – driving long execution duration for Phase 1**
- **Removing strategic alliance contract delays, assuming detailed engineering start in April 2010: duration = 18 months (index 1.50)**

Benchmark Basis:

- **Industry average duration based on facilities cost**
- **Execution duration is from detailed engineering to 1st hydrocarbon or mechanical completion**
- **Benchmark assumes industry average overlap of detailed engineering and fabrication (34 percent)**

Well Construction Duration Model

Phase 1 Is Slower Than Industry



Wells Schedule Analysis Summary
Samarang Project Phase 1

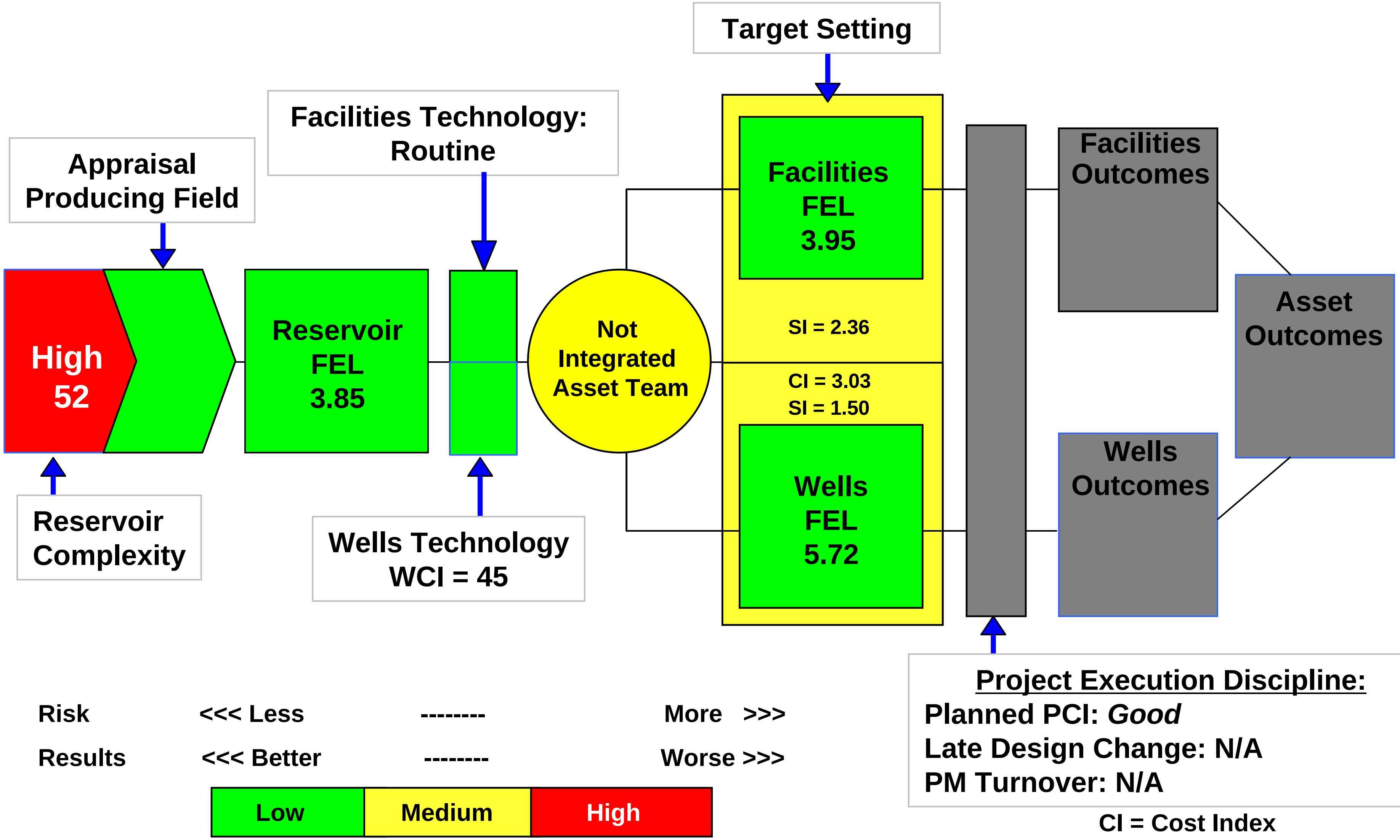
- **Well construction duration is slower than Industry**
  - **On average, Phase 1 will drill at a rate of 6 days/1,000 ft vs. 3.7 days/1,000 ft for industry average**
  - **Multi-zone gravel packs is required for 4 wells which is estimated to be 27 days longer (well program) than single screen completions**

Note:
[1] **Comparison dataset consists of 7 projects with 25 wells in the wells program. 3 of the projects in the set are in Asia Pacific.**

Outline

- Key Message
- Project Background
- Basis of Comparison
- Practices and Drivers
- Targeted Outcomes
- *Conclusions – Phase 1*
- Recommendations

Summary of the Samarang Project Phase 1



Project Execution Discipline:
Planned PCI: *Good*
Late Design Change: N/A
PM Turnover: N/A

CI = Cost Index
SI = Schedule Index
PDA = Production Attainment

Conclusions: Drivers and Practices
Samarang Project Phase 1

- **Reservoir, Facilities, and Well FEL are *Best Practical* – good sign for a successful and predictable outcome**
- ***Fair* TDI driven by lack of fully integrated team (i.e., missing full-time operations representative)**
- **Planned project controls are aligned with Industry**

Conclusions: Targets

Phase 1 Cost Targets Uncompetitive

- **Drilling campaign targets are not competitive (cost or schedule)**
  - **Phase 1 plans to spend about US$94 million to drill and complete 5 wells (US$18.8 million per well)**
  - **Given moderate wells complexity and depth, a similar industry well would cost US$13.0 million**
- **Drilling duration of 154 days for 5 wells is longer than industry average of 108 days for 5 wells**

Outline

- Key Message
- Project Background
- Basis of Comparison
- Practices and Drivers
- Targeted Outcomes
- Conclusions
- *Recommendations – Phase 1*

Recommendations (1)

Determine Critical Dates & Develop Contingency Plans

- **Determine critical dates for all approvals and awards; develop contingency plans and trigger dates in event that critical dates cannot be met**
  - **Review schedule to determine effect of delays in onshore/HUC work prior to drilling campaign, particularly during the monsoon window**
  - **Develop contingency plans if approval of HUC contract is anticipated to delay past June 2010**
  - **Determine trigger dates to execute the contingency plans**
  - **Inform management of critical dates and contingency plans to obtain buy-in**

Recommendations (2)

Allocate Sufficient Contingency for Drilling

- **Ensure sufficient contingency is allocated to cover drilling risks, especially for fault tracking drilling technique and K sands**
  - **Although risk is understood by team and Wells FEL is strong, execution risk still remains because location of faults is not confirmed**
  - **This will be first time gravel pack is not used in K sand based on borehole stability study—poses major risk since topside lacks sand handling equipment**

Recommendations (3)

Resist Request to Split Team to Separate Locations

- **Resist PCSB request to split subsurface and wells teams to separate locations**
  - **Historically, projects have not performed well once team splits into various locations**
    - > **It will affect team dynamics and erode team effort to date**
- **If this is inevitable, team must devise and diligently follow communication plan to minimise project risks**

Recommendations (4)
Mobilise Operations Representative

- **Assign full-time operations representative to team**
  - **Permanent operations representative will allow better communication and faster decisions**
  - **Ensure operations representative is acknowledged and appointed by offshore operations team**

Outline

- **Key Message**
- **Project Background**
- **Basis of Comparison**
- ***Practices and Drivers – Phase 2***
- **Targeted Outcomes**
- **Conclusions**
- **Recommendations**

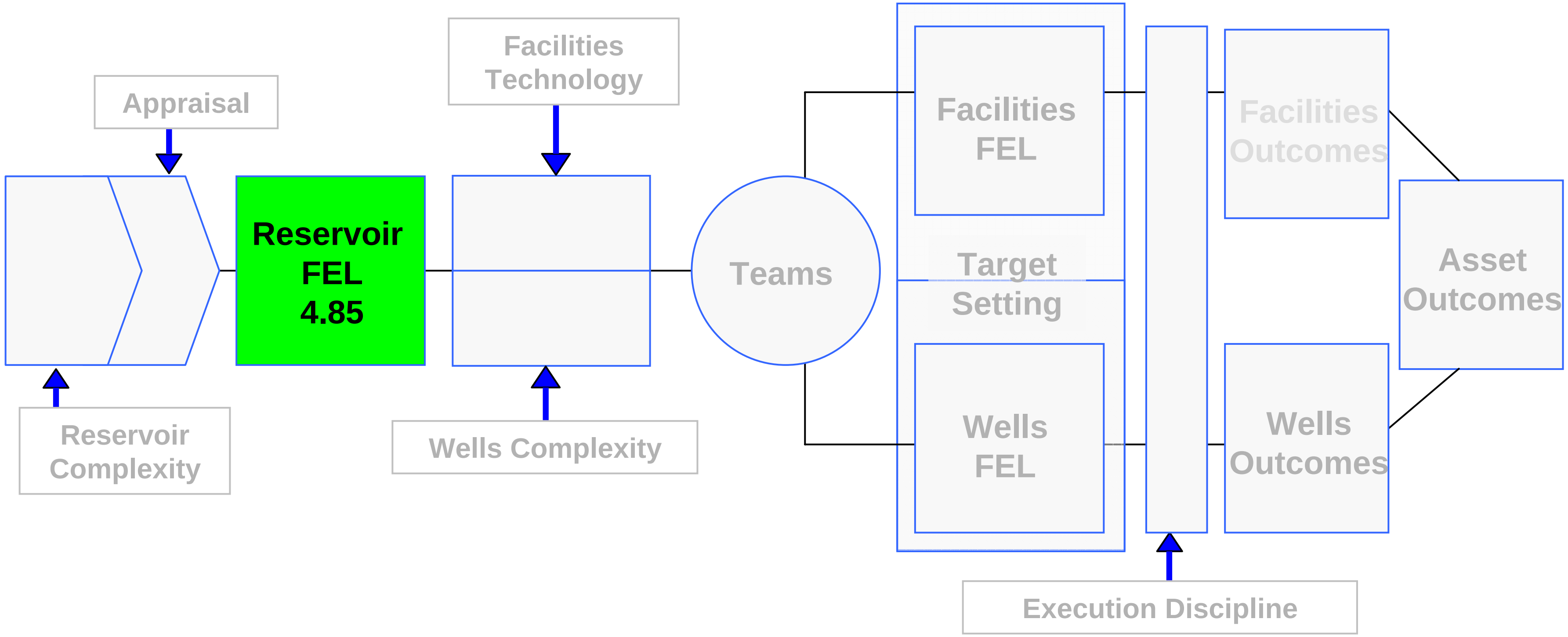
Why Is FEL 2 the Most Important Phase?

- **Starting FEL 3 without completing FEL 2 is almost always the root cause of several problems:**
  - **Projects that get delayed, recycled, or cancelled during FEL 3**
  - **Projects that do not meet the business need after they are put into operation**
  - **Projects that reach *Best Practical* FEL, but do not have competitive outcomes**

Goals for FEL 2

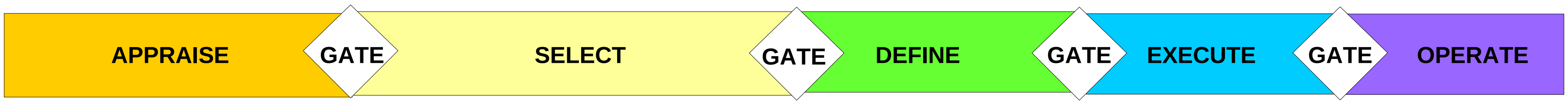
- **Goals for FEL 2**
  - **Align project objectives with business objectives**
  - **Develop a reliable cost estimate to judge the robustness of the business case**
  - **Set competitive cost and schedule targets**
- **Key Practices**
  - **Clearly defined business and project objectives**
  - **Integrated team during FEL 2**
  - **Completing engineering definition**

Drivers of Project Success
Reservoir FEL



Risk	**<<< Less**	**--------**	**More >>>**
Results	**<<< Better**	**--------**	**Worse >>>**

Low	**Medium**	**High**



Reservoir Front-End Loading

Inputs

- Seismic
- Logs
- Cores/SCAL
- Fluid Properties
- Well & Reservoir Tests
- Pressures
- Production History Analogs

Constraints

- Regulatory/ Environmental
- Timing
- Budget
- Appraisal Strategy
- Operating Constraints
- Technology/Tolerance for Risk
- Business Commercial Strategy Issues
- Joint Operating Agreement Issues

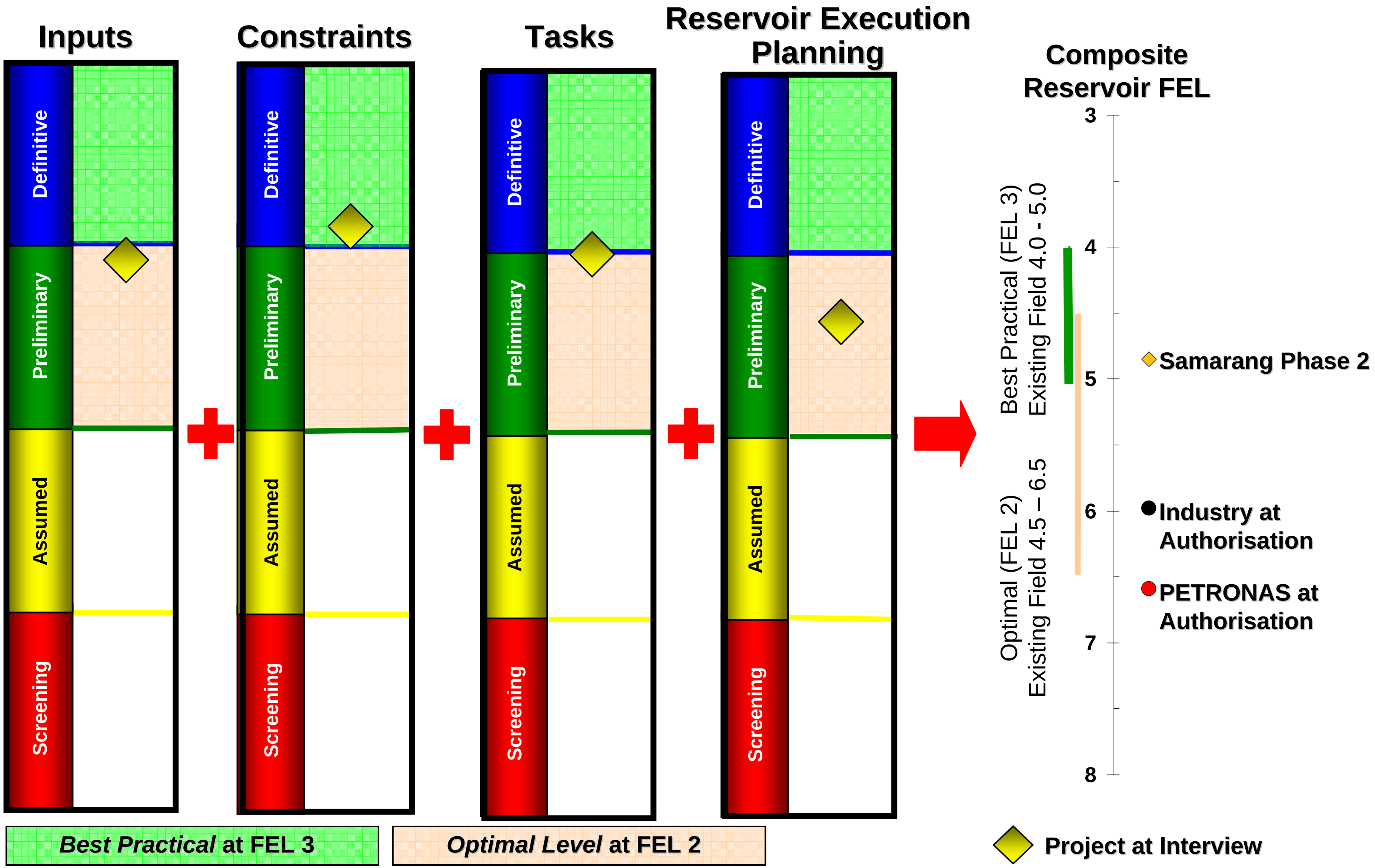
Tasks

- Interpret Seismic
- Develop Maps and Geologic Model
- Integrate Wells Team
- Characterise Fluids
- Complete Reservoir Design Basis
- Understand Drive Mechanism
- Define Compartments
- Predict Production Profiles and Reserves
- Complete Risk and Uncertainty Analysis

Execution Planning

- Subsurface Team Interactions
- Schedule Development
- Plans/Documents Completed
- Controls in Place

Reservoir FEL by Component
Optimal for Phase 2 at End of FEL 2



Reservoir FEL Status (1)
Samarang Project Phase 2

Inputs – *Preliminary* (*Optimal*)

- **Field in production for 30 years with over 140 wells**
- **Logs, pressure, and fluid data received**
- **Cores taken in 1970s but sample has eroded over time**
  - **Plans to take a full core sample during Phase 1 drilling program**
    - **To gather information on deeper sand characteristics for EOR scope in Phase 2**
- **Injectivity test**
  - **1 injectivity well test to date**
  - **Second test will be done in 2010 – crucial to project as water and gas injection will be used**

Reservoir FEL Status (2)
Samarang Project Phase 2

Constraints – *Definitive* (*Optimal*)

- **Similar to Phase 1, strategic alliance contract in negotiation for over 12 months**
  - **Expected to be signed on 23 March 2010**
- **New core information required to assist in EOR development for Phase 2**
- **Management expectation for use of GASWAG EOR technology – will be first full-scale implementation EOR for PETRONAS**
  - **Management expectations are to use such techniques in other fields in future**

Reservoir FEL Status (3)
Samarang Project Phase 2

Tasks – *weak Definitive* (*Optimal*)

- **All seismic activities and 3D simulations done as part of work in Phase 1**
  - **Drive mechanisms understood, production profile peer reviewed, and 3D models defined for field**
- **Well locations not yet identified**
- **Further work to determine EOR GASWAG viability will be done after core and Phase 1 drilling is completed**

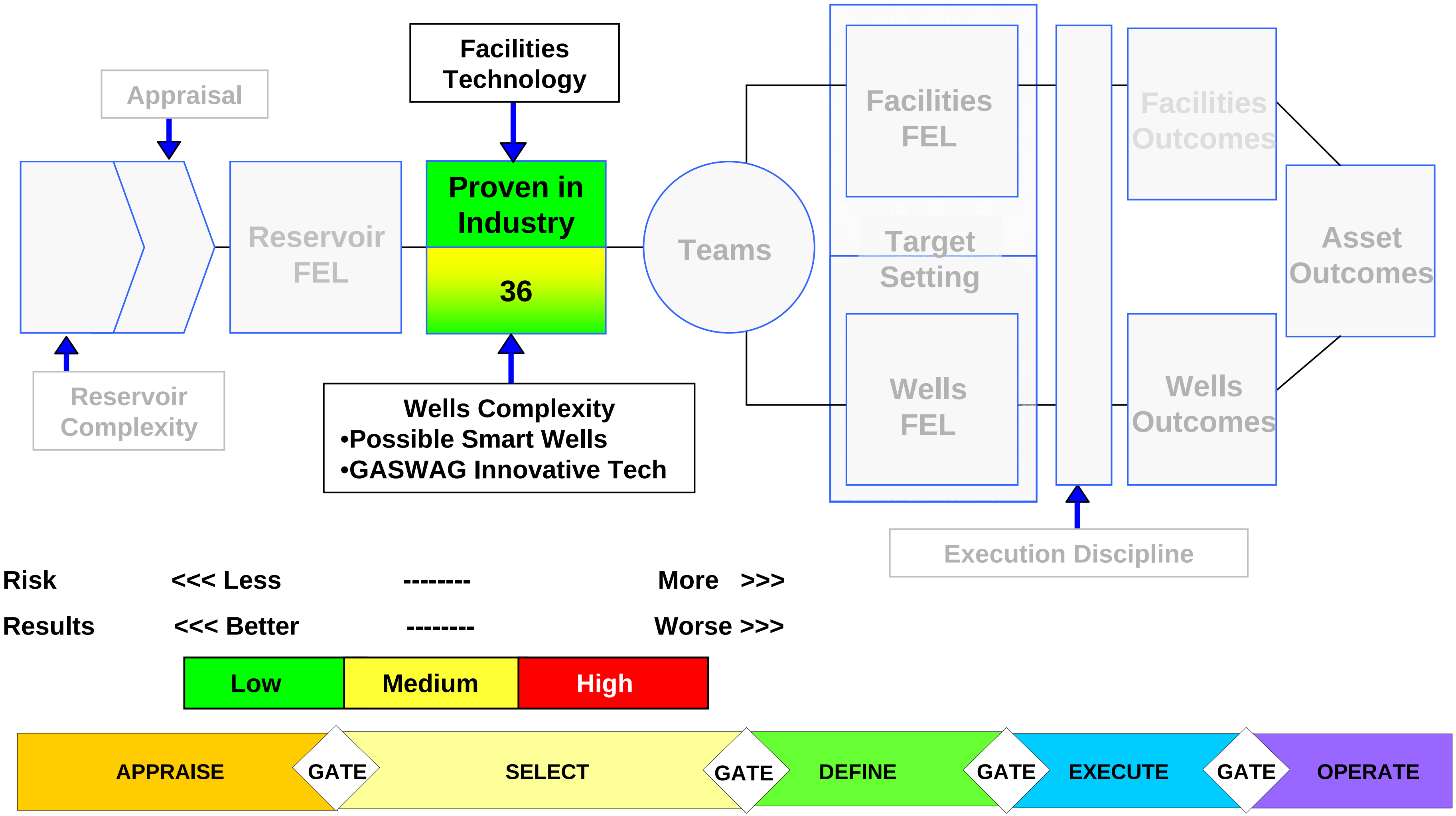
Reservoir FEL Status (4)
Samarang Phase 2 Project

Execution Planning – *Preliminary* (*Optimal*)

- **Similar to Phase 1, subsurface team of Schlumberger and PCSB personnel are well integrated**
- **Roles and responsibilities defined and understood by core team**
- **High level subsurface schedule developed**
- **Preliminary Basis of Memorandum, Integrated Reservoir Management Plan, and FDP prepared**

Drivers of Project Success

Facilities and Wells Complexity



Well Complexity Index
Phase 2 Less Complex Than Industry

- **Phase 2 well designs are less complex than Industry**

Complexity Category	Gas Injectors	Water Injectors	Oil Producers	Industry Average
Subsurface Hazards	6	6	6	15
Reservoir Interface	11	11	15	16
Well Geometry	9	9	9	11
Rig Equipment	5	5	5	11
Environmental and Meteorological Conditions	4	4	4	6
Total Well Complexity Index	**35**	**35**	**39**	**59**

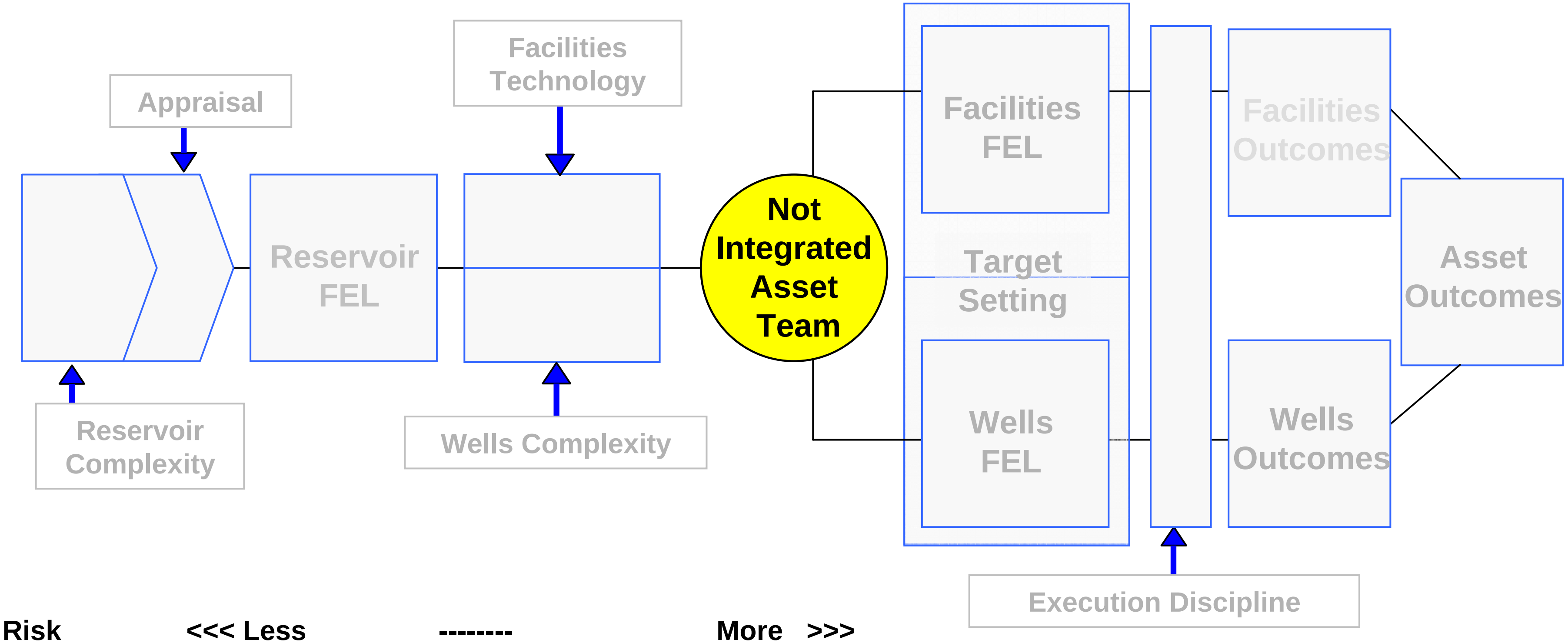
- **However, Phase 2 will implement GASWAG EOR**
  - **Use of water and gas injection technology separately proven in Industry; combined use of gas and water injections are new to Industry**

Facilities Technology
Samarang Project Phase 2

- **Conventional technology**
- **Similar to Phase 1 for platforms:**
  - **SMJT-AA and infill wells using conventional wellhead designs**
  - **SMG-AA will have similar process controls as current design on Samarang**
  - **SMW-B using industry proven technology**
- **Team is familiar with technology**

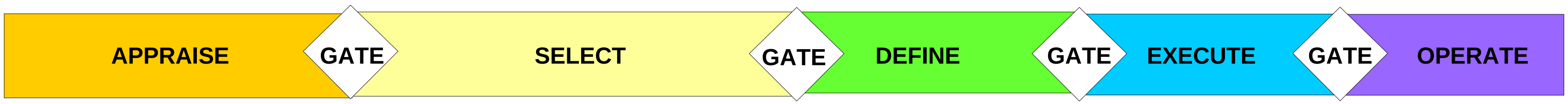
Drivers of Project Success

Not Integrated Asset Team



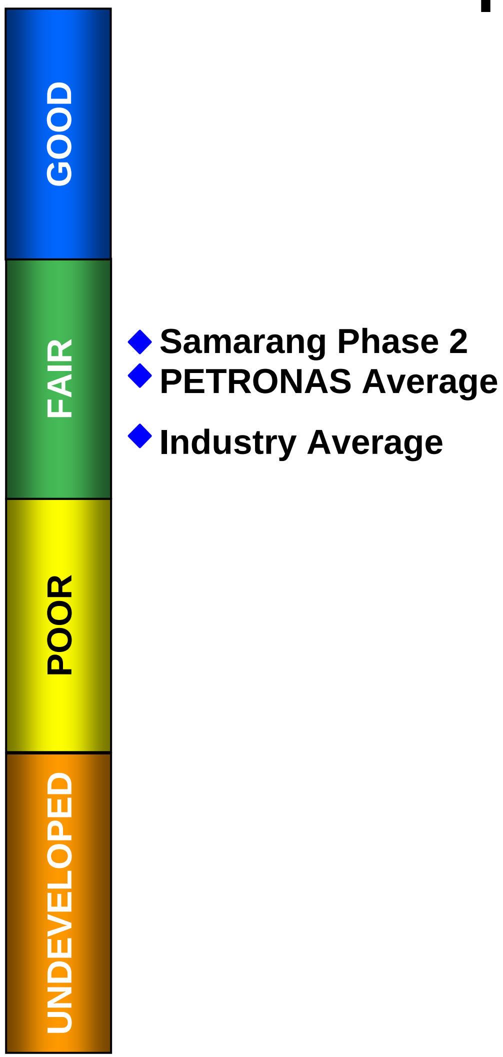
Risk	**<<< Less**	**--------**	**More >>>**
Results	**<<< Better**	**--------**	**Worse >>>**

Low	**Medium**	**High**



Team Development Index (TDI)

Saramang Phase 2 TDI Is Fair



Phase 2 has fulfilled most of team practices:

- ☑ *Project objectives defined, understood, and agreed to* **Samarang Phase 2 objectives are aligned with business objectives and are understood by project team**

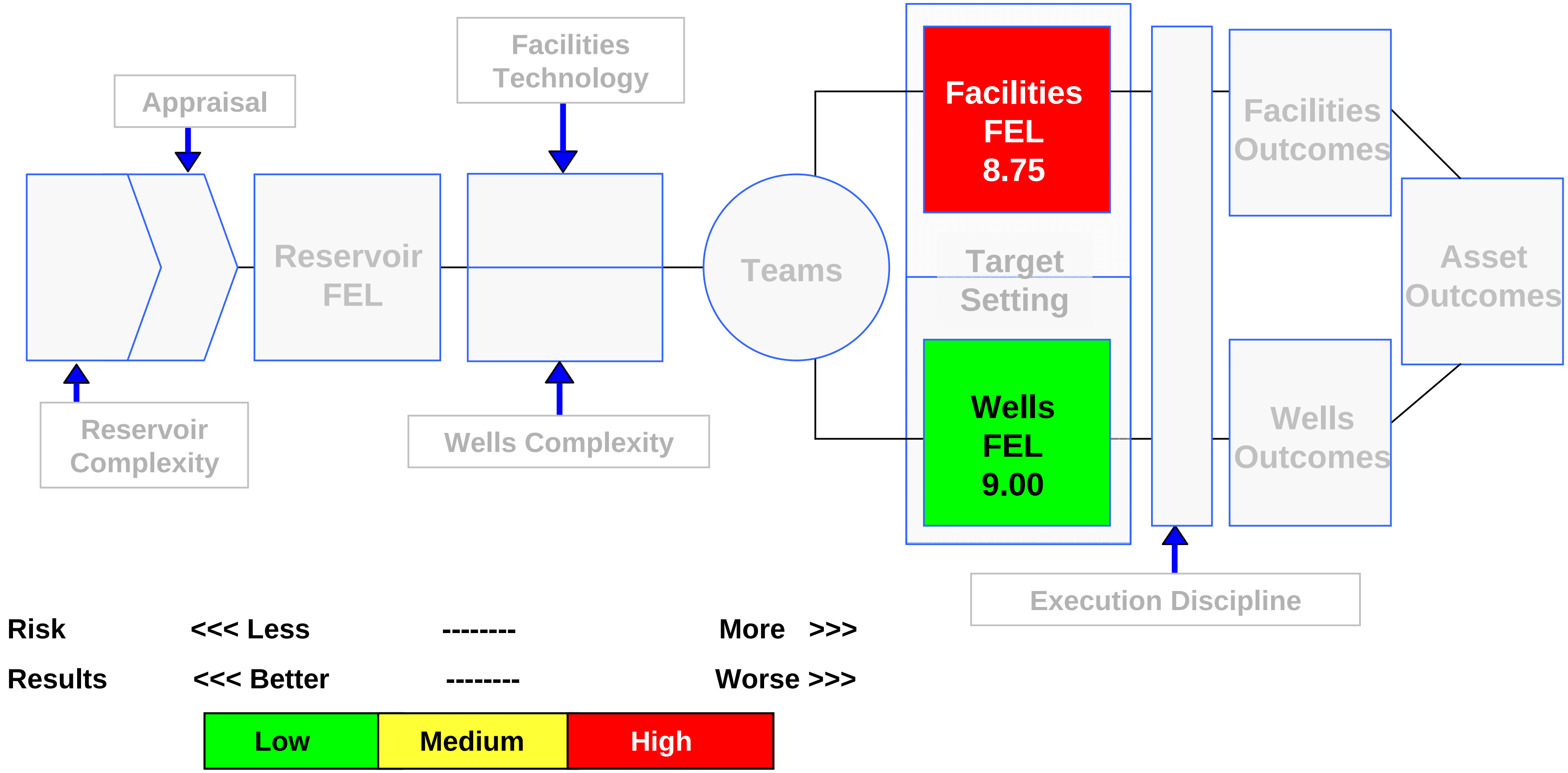
- ☒ *Operations representative lacking* **Team receives inputs from offshore operations team but lacks dedicated operations representative**

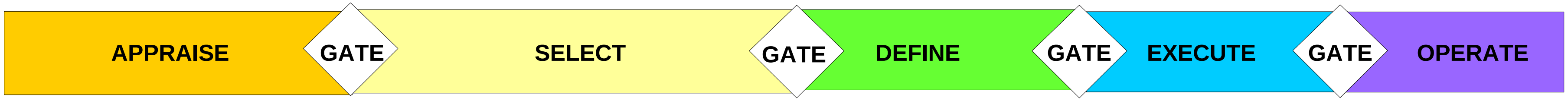
- ☑ *Team roles and responsibilities defined, understood, and agreed to*

- ☑ *Major tasks and problems identified and planned for (typically using a risk assessment)* **Risk register set up for use by various functions; major tasks and issues identified and monitored, mitigation plans are in place**

- ☑ *PETRONAS Project Management System process is followed*

Drivers of Project Success
Facilities FEL and Wells FEL



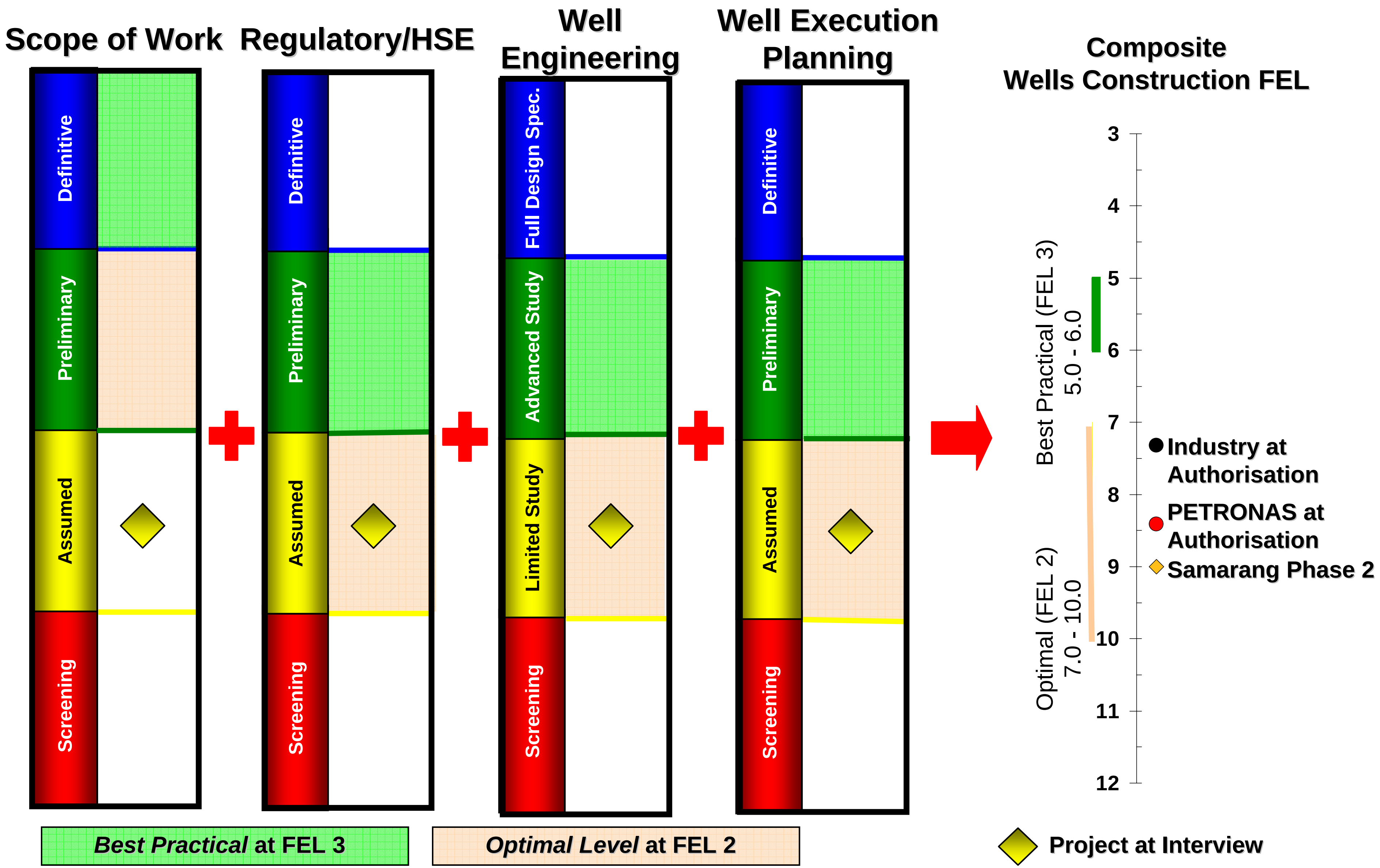


Well Construction Front-End Loading

Scope of Work	Regulatory HSE	Well Engineering	Execution Planning
• Offset Wells • Commercial • Well Objectives • Scope of Work • Location Survey • Metocean Data • All Needed Technical Inputs	• Permitting • Preliminary Safety Management Plan • Hazid Analysis • Company Policies • Waste Management	• Casing Design • Completion and Stimulation Plans • Certify Rig • Certify Equipment • Long-Lead Items Identification • Scenario and Option Planning • Peer Review • Stakeholder Buy-in	• Contracting Strategy • Team Composition • Procurement Plan • Secured Rig • Logistics • Schedule Estimate including concurrent ops, SIMOPs, etc. • Detailed Well Plan to Achieve Objectives • Program Cost Estimate

Well Construction FEL by Component

Optimal for Phase 2 at FEL 2



Wells FEL Status (1)
Samarang Project Phase 2

Scope of Work – *Assumed* (*Optimal* is *Preliminary*)

- **Team has good understanding of Samarang environment**
  - **However, soil and seabed strength of jack-up rig location not yet investigated**
    - **> Soil boring planned in March 2010**
- **Number of wells to be confirmed**
- **Phase 2 drilling program objectives not yet developed and confirmed with business group**
- **FDP will be submitted to PMU in 2011 for authorisation**

Wells FEL Status (2)

Samarang Project Phase 2

Regulatory/HSE – *Assumed* (*Optimal*)

- **Permit requirements for drilling identified but no permit submitted—drilling phase is 2 years away**
- **HSE management plan will be similar to current operations, as drilling activities are ongoing within PCSB**
- **Permission obtained from government to dump water based mud to sea**

Wells FEL Status (3)

Samarang Project Phase 2

Planning – *Assumed* (*Optimal*)

- **Similar to Phase 1: core team is in place, including completion team**
- **Drilling services and tubular contracts are in place**
- **Rig types defined but no rigs identified to date**
- **SIMOPS identified, will be further developed as project progresses**

Wells FEL Status (4)

Samarang Project Phase 2

Engineering – *Limited Study* (*Optimal*)

- **Preliminary surface and bottomhole locations identified**
- **Fault tracking technique to be further planned for Phase 2 – currently determined using offset logs and seismic**
- **2009 well bore stability study says gravel packing not required for K sand**
  - **Per study, no plans for platform based sand removal facilities**
    - **Poses major risk if studies wrong, as current designs use gravel packs**
- **Material selection study ongoing for carbon dioxide and water combination in the injection wells**
- **Smart well designs also being considered**

Facilities Front-End Loading

Project Specific Factors

- Soils and Surveying
- Permit Requirements
- Concession Terms
- Import/Export Terms
- Community Relations
- Security
- Offshore Persons on Board Requirements
- Support and Logistics
- Local Content
- Local Labour
- HSE for Operations
- HSE for Fabrication, Transport, and Installation
- Yard Availability

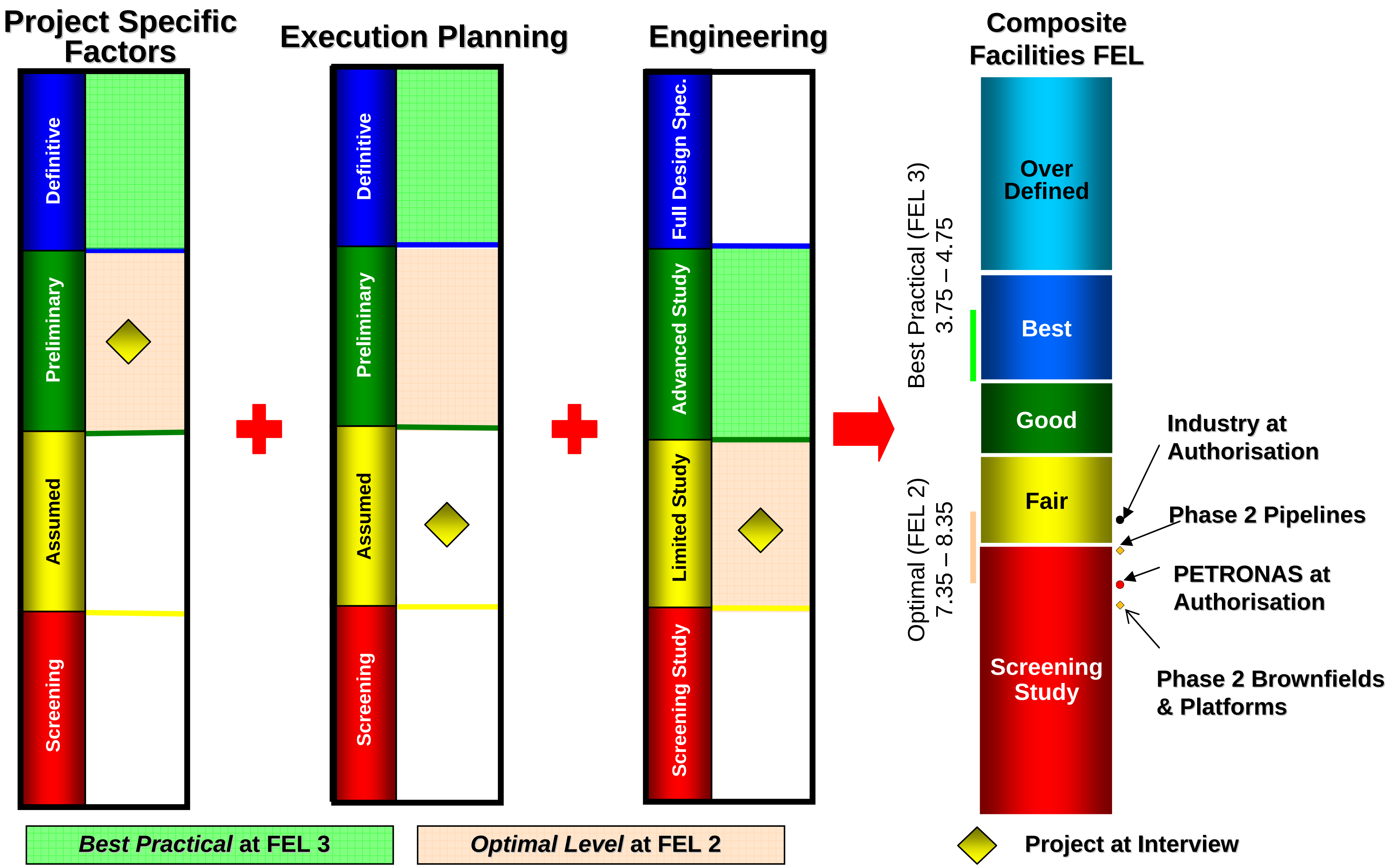
Execution Planning

- Contracting strategy
- Team participants & roles
- Integrated schedule
  - Critical-path items
  - Identification of shut-down for tie-ins
  - Resources
  - Overtime
- Plans
  - Commissioning
  - Startup
  - Operation
  - Well construction
  - Quality assurance
- Cost and schedule controls

Engineering

- Engineering tasks
  - Fluid Definition
  - Detailed scope
  - PFDs
  - H&MBs
  - Preliminary P&IDs
  - One-line elec. diagrams
  - Major equipment specifications
  - Cost estimate
- Participation/buy-in of:
  - Operations
  - Maintenance
  - Business
  - Subsurface

Offshore Facility FEL by Component
Phase 2 Lags Optimal at FEL 2



Facilities FEL Status (1)

Samarang Project Phase 2

Project Specific Factors – *Preliminary* (*Optimal*)

- **Soils, metocean, and surveying data available**
- **Local labour supply generally understood**
- **Local content known and understood**
- **Allowable POB on platforms assumed based on previous projects**
- **Fab yards in Malaysia known and identified, but availability for fabrication not known**
- **Floatel/crane barge planned through PCSB existing contracts**

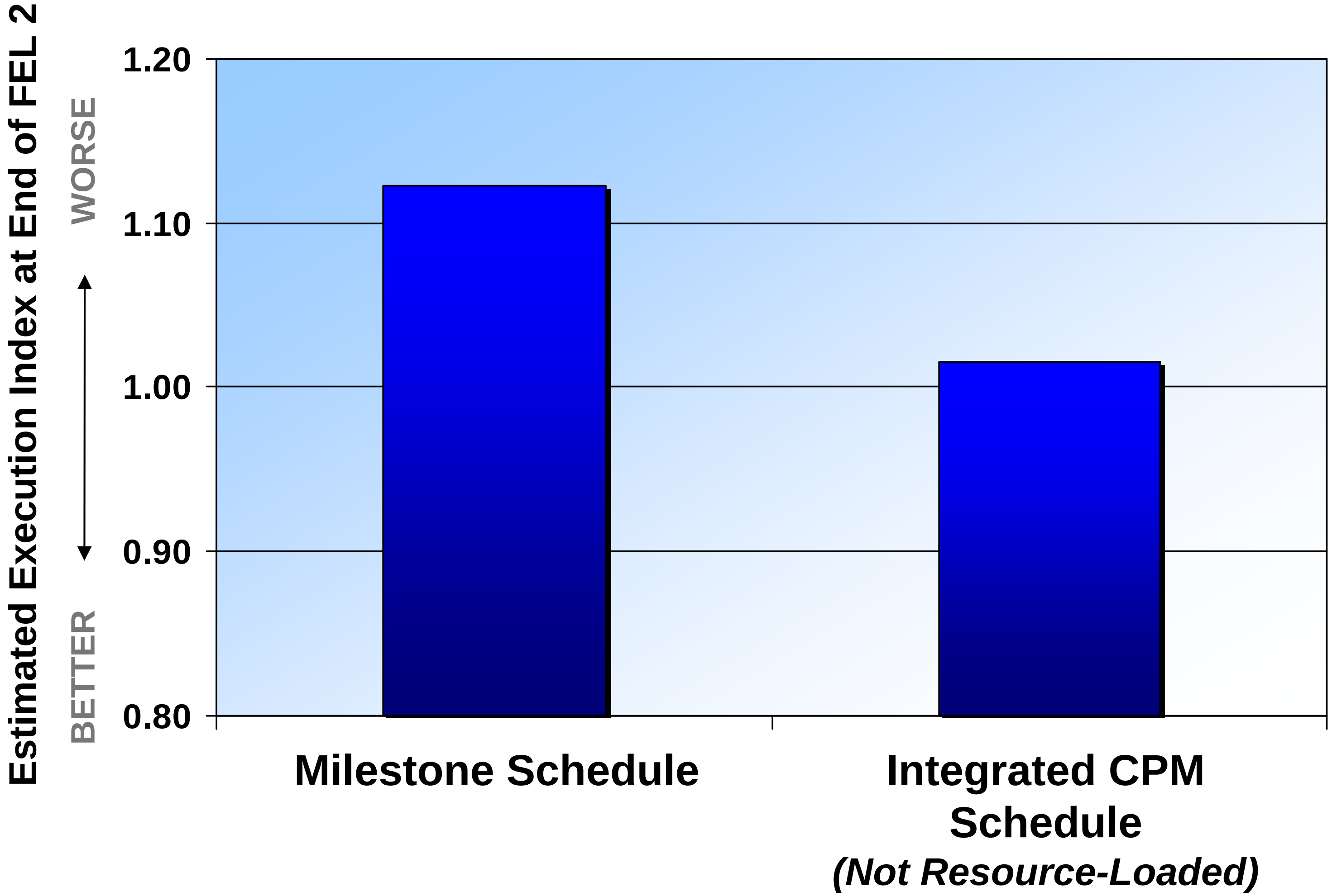
Facilities FEL Status (2)

Samarang Project Phase 2

Execution Planning – *Assumed* (*Optimal* is *Preliminary*)

- **Team organisation chart defines team structure and positions with documented roles and responsibilities**
  - **Detailed manpower plan prepared for entire project lifecycle**
- **Comprehensive PEP prepared covering both phases (1&2) but with greater emphasis and details on Phase 1**
- **Phase 2 schedule prepared**
  - **Many key milestones listed; Critical path not well defined**
  - **Offshore revamp scope lacks details**
  - **Assumed allowable POB on platforms during HUC scope not yet confirmed with operations**

Level of Schedule Detail at End of FEL 2 Affects Execution Schedule Competitiveness



Facilities FEL Status (4)

Samarang Project Phase 2

Engineering – *Limited Study* (*Optimal*)

- **PFDs completed, reviewed by site-based operations team**
- **Preliminary utility and infrastructure analysis completed**
- **Equipment list and major piping sizes completed and finalised**
- **Preliminary structural weight calculations done for deck extensions**
- **Factored cost estimate developed, based on recently completed projects**
- **However, Phase 2 FEED will overlap with subsurface analysis which might drive late changes**

Asset FEL Components

Reservoir FEL + Facilities FEL + Wells FEL → Asset FEL

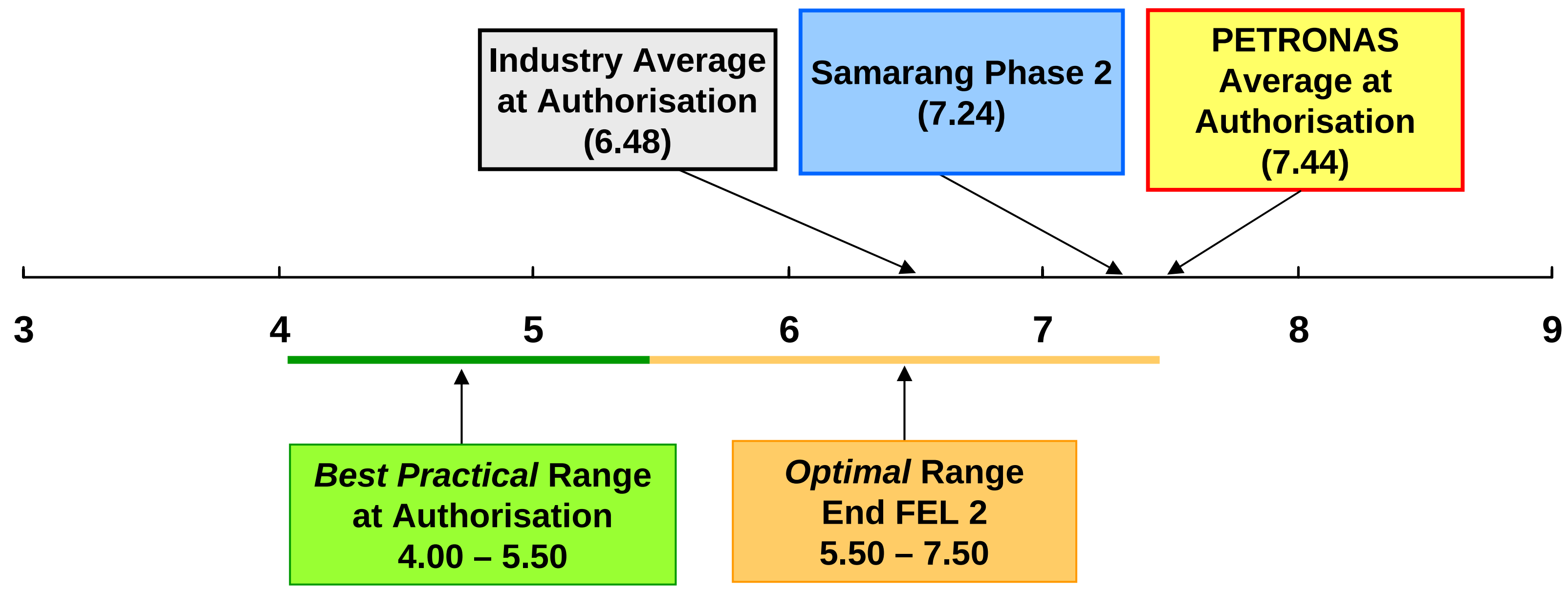
- Inputs
- Constraints
- Tasks
- Planning

- Site Factors
- Engineering
- Planning

- Scope of Work
- Regulatory
- Engineering
- Planning

Asset FEL

Phase 2 Just Within Optimal Range at End of FEL 2

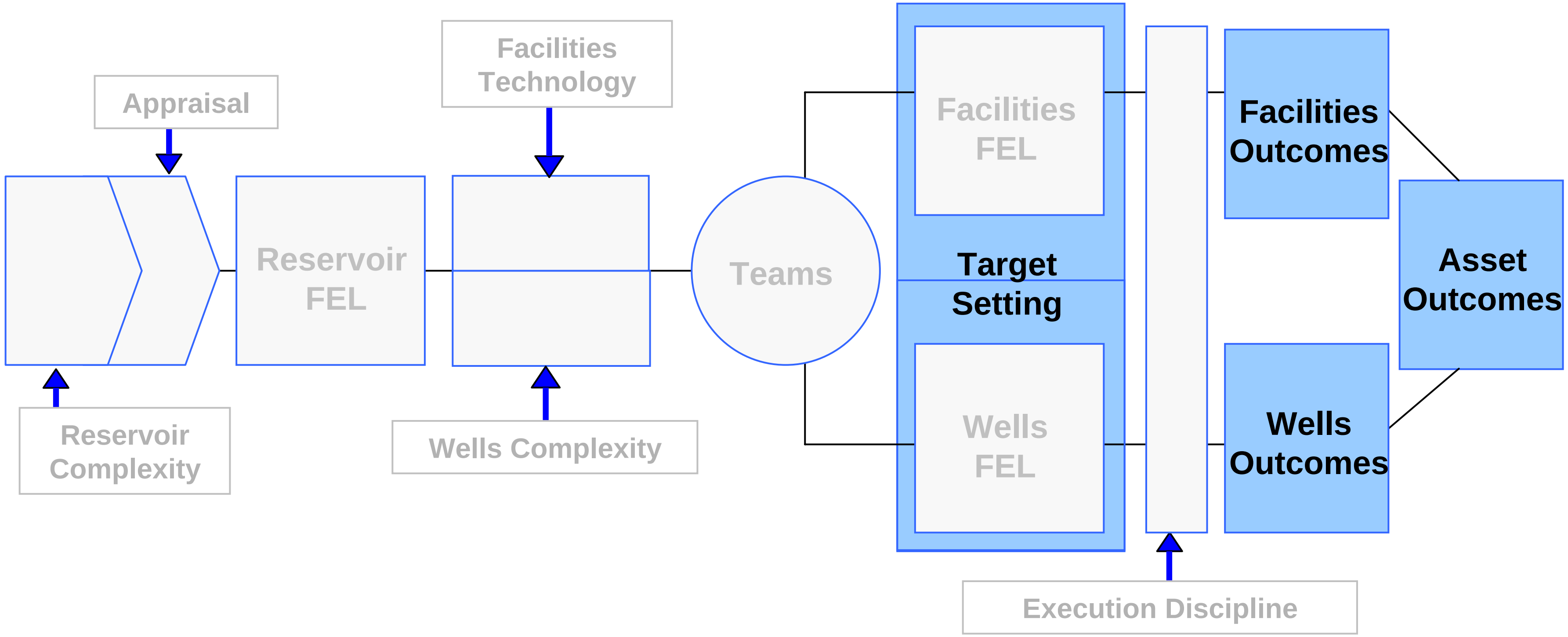


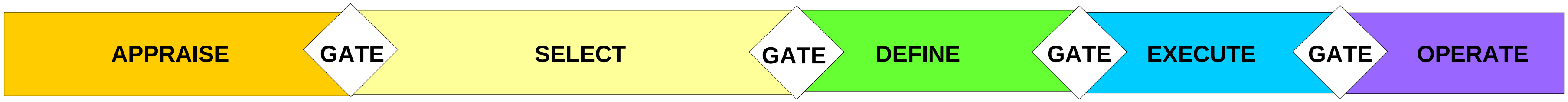
Outline

- Key Message
- Project Background
- Basis of Comparison
- Practices and Drivers
- *Targeted Outcomes – Phase 2*
- Conclusions
- Recommendations

Pathway to Asset Success

Planned Outcomes





Pathway to E&P Project Success
Metrics Applicable to Samarang Phase 2

$/BOE Asset Development Effectiveness

– $/BOE for facilities and well program

Individual Component Benchmarks

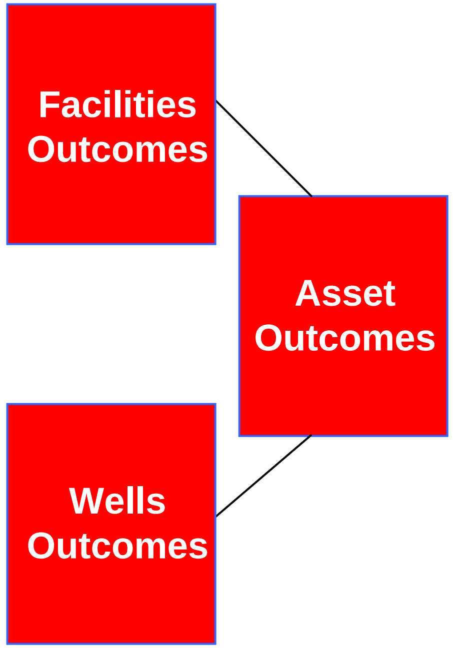
– Wells program competitiveness (as designed)

– Platform cost competitiveness (as designed)

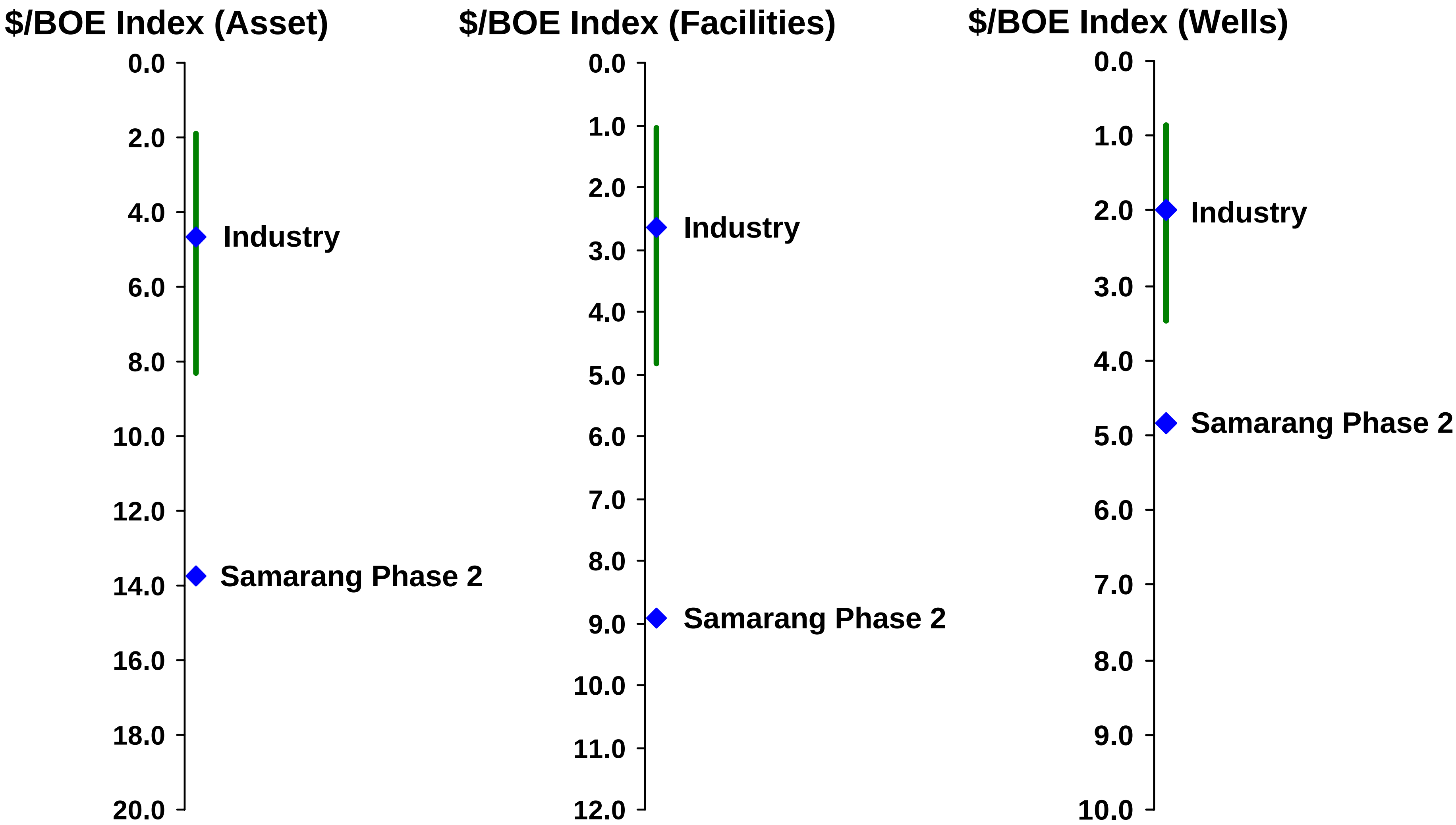
– Pipeline cost competitiveness (as designed)

UCEC Analysis

– Comparison of cost line items with similar projects



Cost Competitiveness Analysis
$/BOE Targets Are Uncompetitive



Note:
1. The solid bar line represents the industry ranges normalised for BOE and water depth

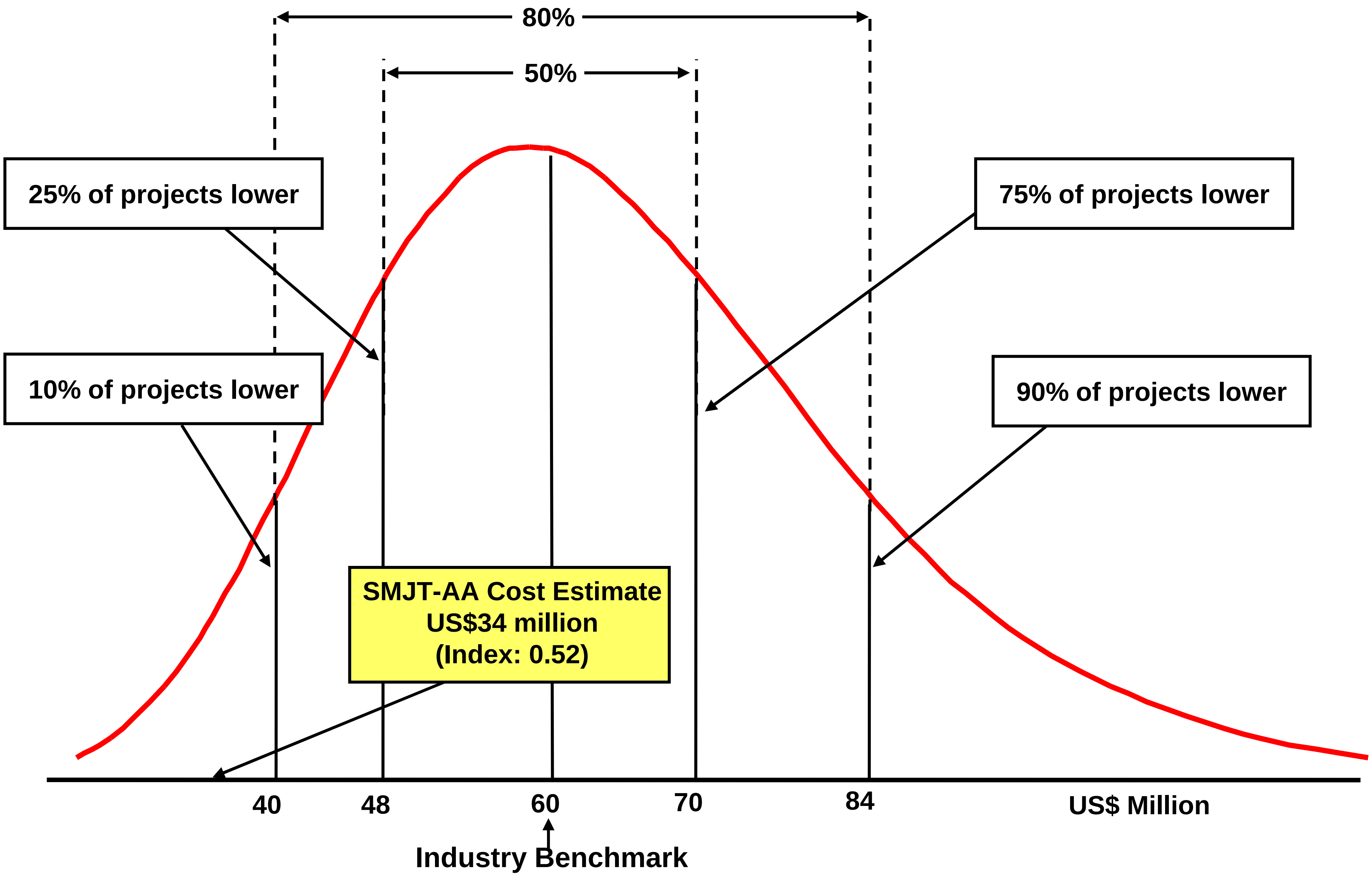
Cost Analysis – $/BOE

Phase 2 $/BOE Is Uncompetitive

- **Asset $/BOE is more expensive than Industry for both facilities and wells**
- **Phase 2 recoverable volume is 64 MMBOE – nature of Samarang Phase 2 infill drilling and EOR scope is more capital intensive than other greenfield projects, hence driving:**
  - **Uncompetitive Facilities $/BOE**
  - **Uncompetitive Wells $/BOE**

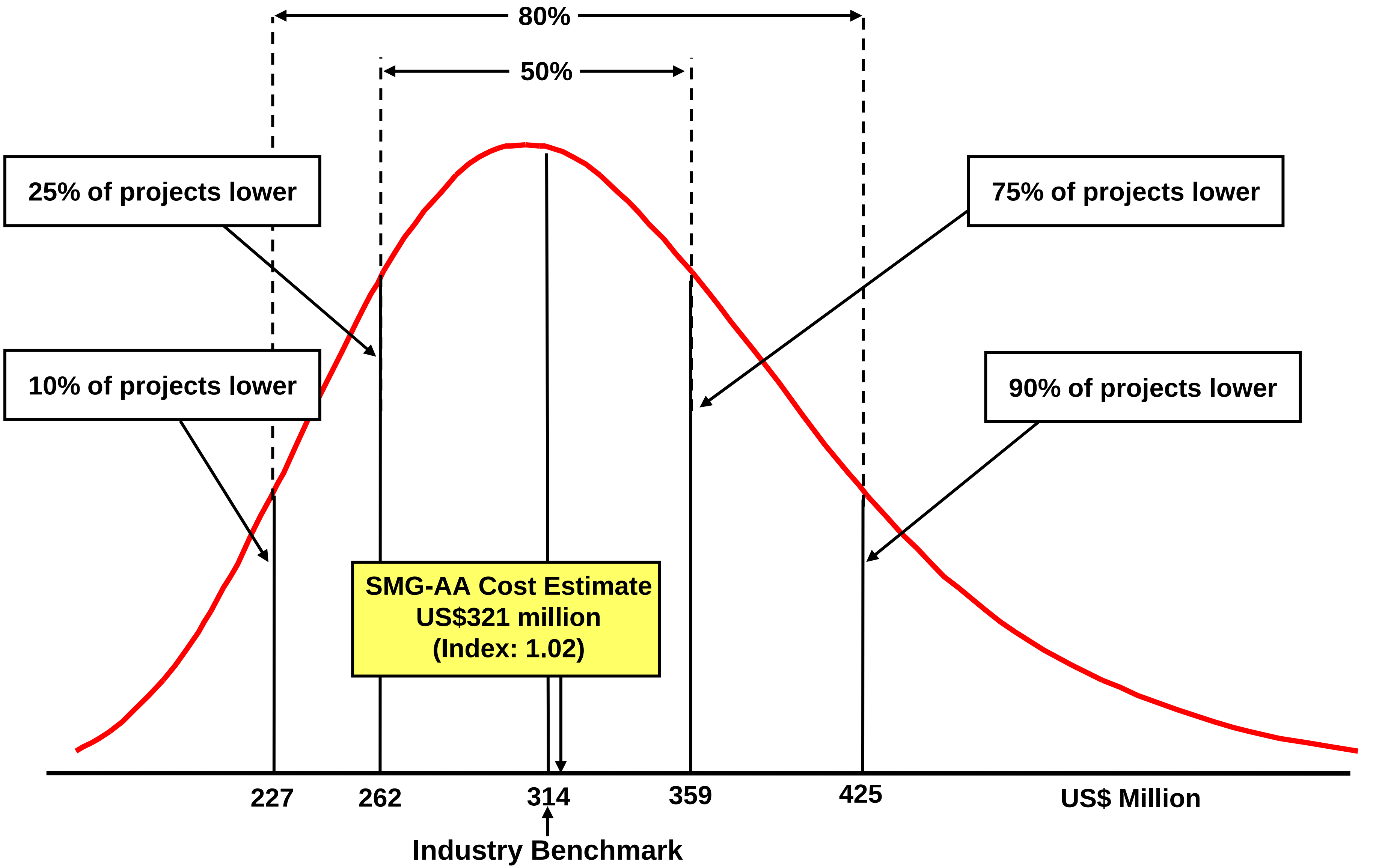
Platform Cost Estimate

SJMT-AA Cost Estimate Is Aggressive



Platform Cost Estimate

SMG-AA Cost Lies Within P50 Industry Range



Cost Analysis

SMJT-AA & SMG-AA Platforms Summary

- **SMJT-AA drilling platform is 48 percent lower than industry average – *what is driving this aggressive target?***
- **SMG-AA processing platform estimate is comparable with industry average for similar topside functionality**

Cost Analysis
SMW-B Cost Summary

- **UCEC 2009 data used to compare SMW-B platform cost based on jacket and topside cost and weight**

Platform Summary – Jacket and Topside Weight

	Topside Weight (metric tonne)	Jacket Weight (metric tonne)	Piles Weight (metric tonne)	Total (metric tonne)
SMW-B	2,530	977	1,392	4,899

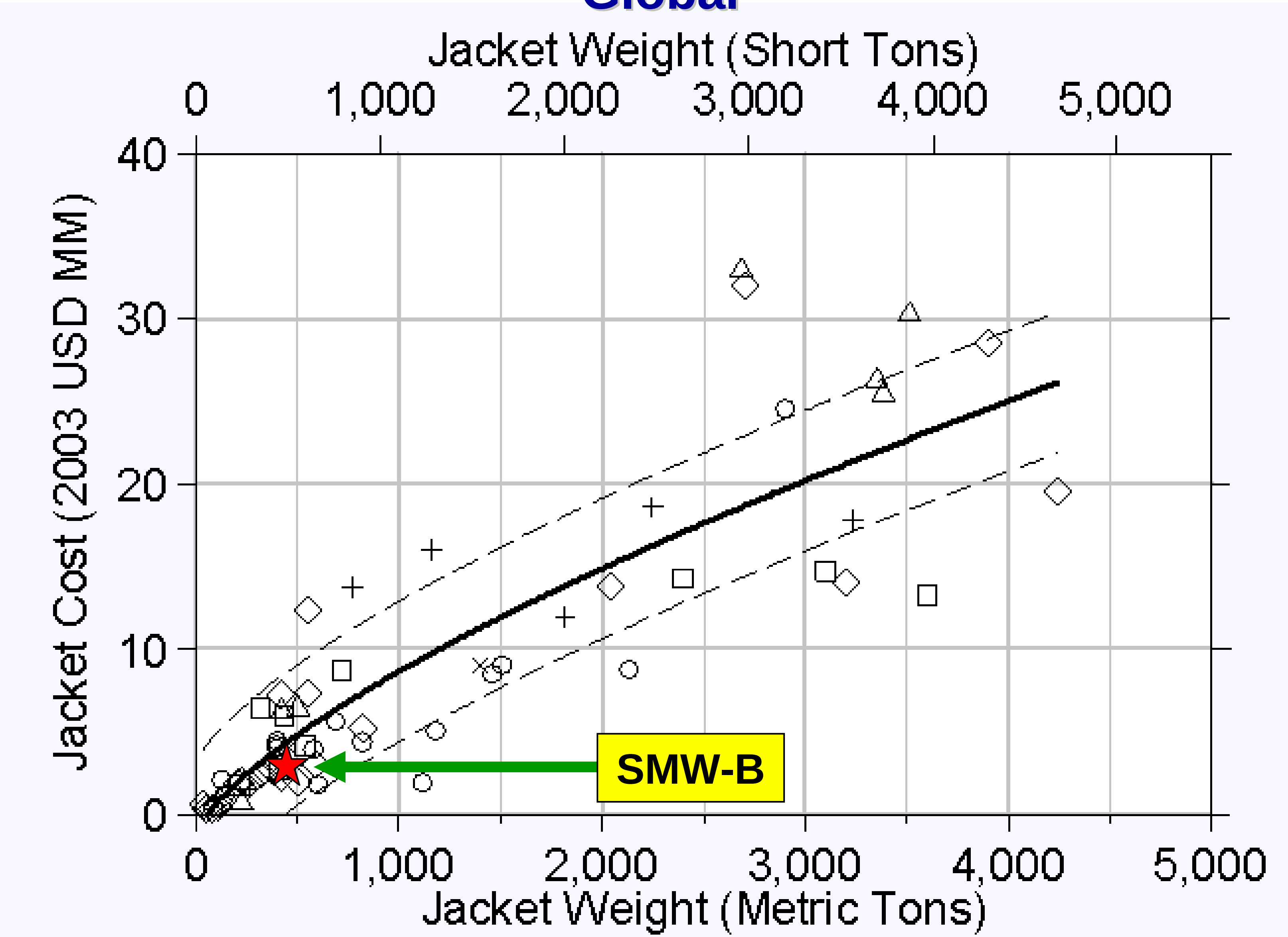
Platform Summary – Prorated Substructure and Topside Cost[1]

	Topside Cost (US$ Million)	Substructure Cost (US$ Million)	Total Cost (US$ Million)
SMW-B	90.9	7.3	98.2

Note:
1. Engineering, PMT, Installation, HUC, and other costs have been prorated into topside and substructure costs

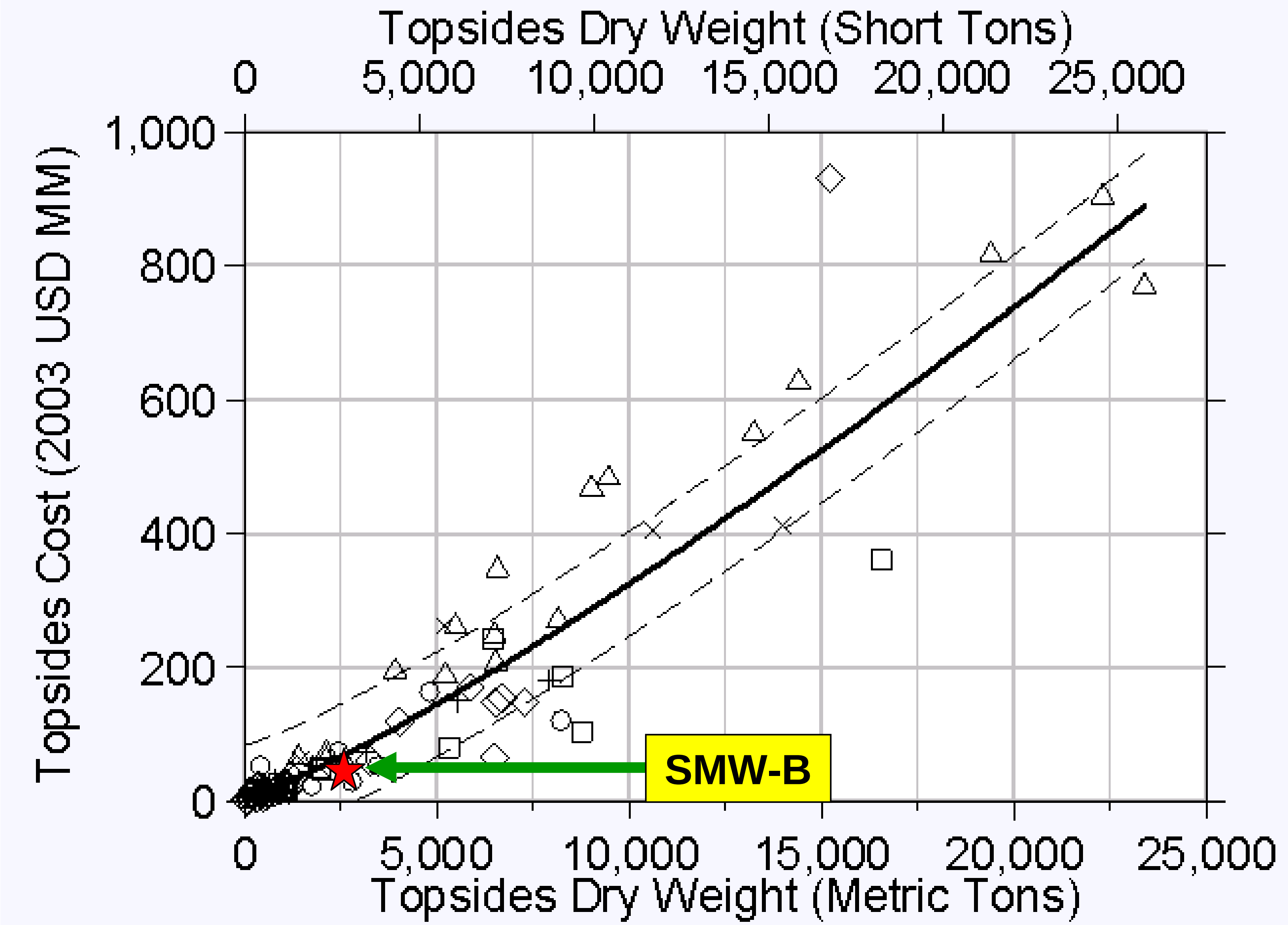
Jacket Cost vs. Jacket Weight

Global



Topsides Cost vs. Topsides Weight

Global



Cost Analysis
SMW-B UCEC Comparison

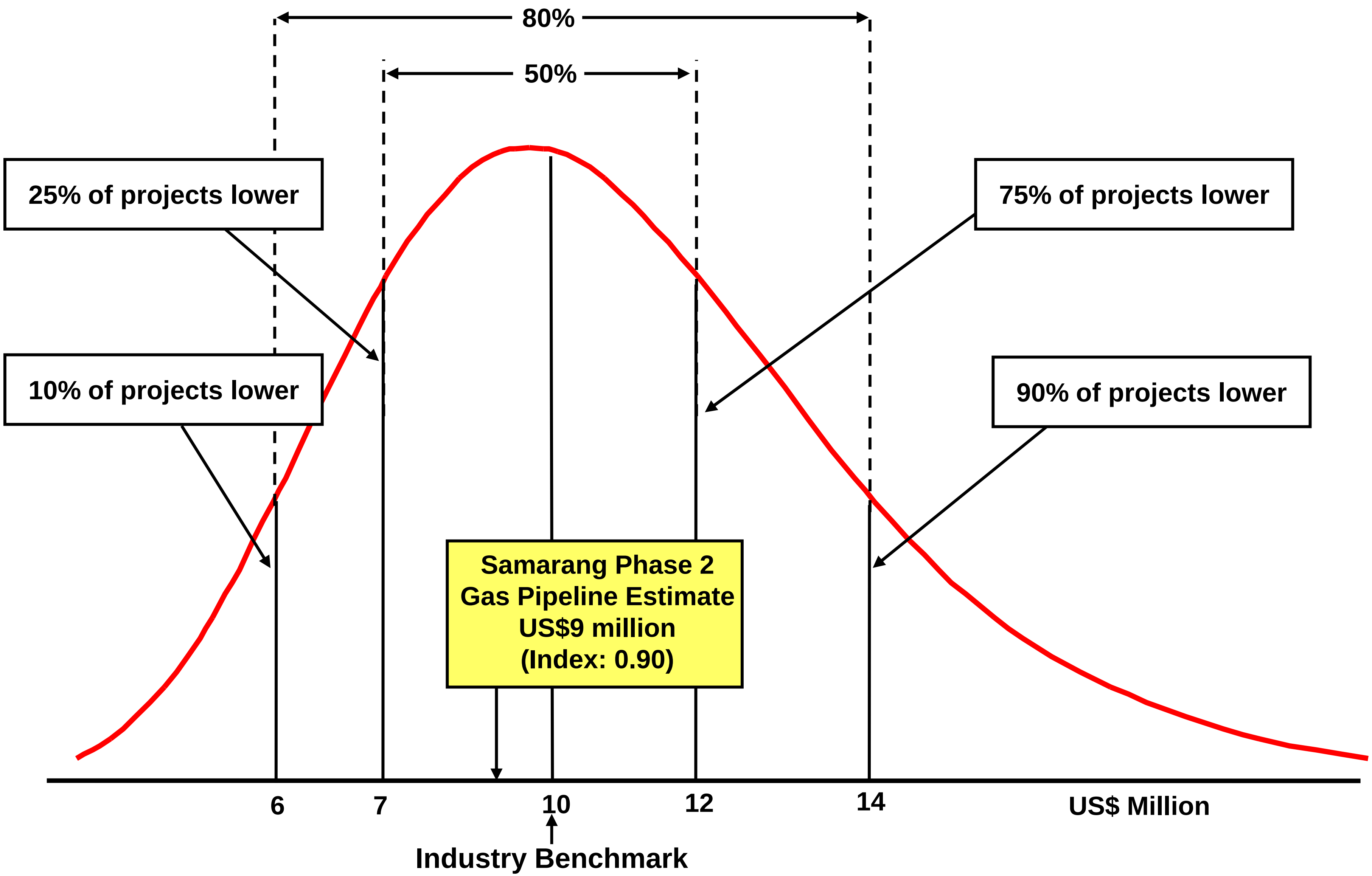
- **SMW-B cost is aggressive for given topside and jacket weight**

SMW-B Comparison with UCEC

	SMW-B Cost (US$ million)			**UCEC Cost (US$ million)**		
	Topside	Jacket	Total	Topside	Jacket	Total
SMW-B (Index)	90.9 (0.74)	7.3 (0.48)	98.2 (0.71)	122.7 (1.00)	15.4 (1.00)	138.1 (1.00)

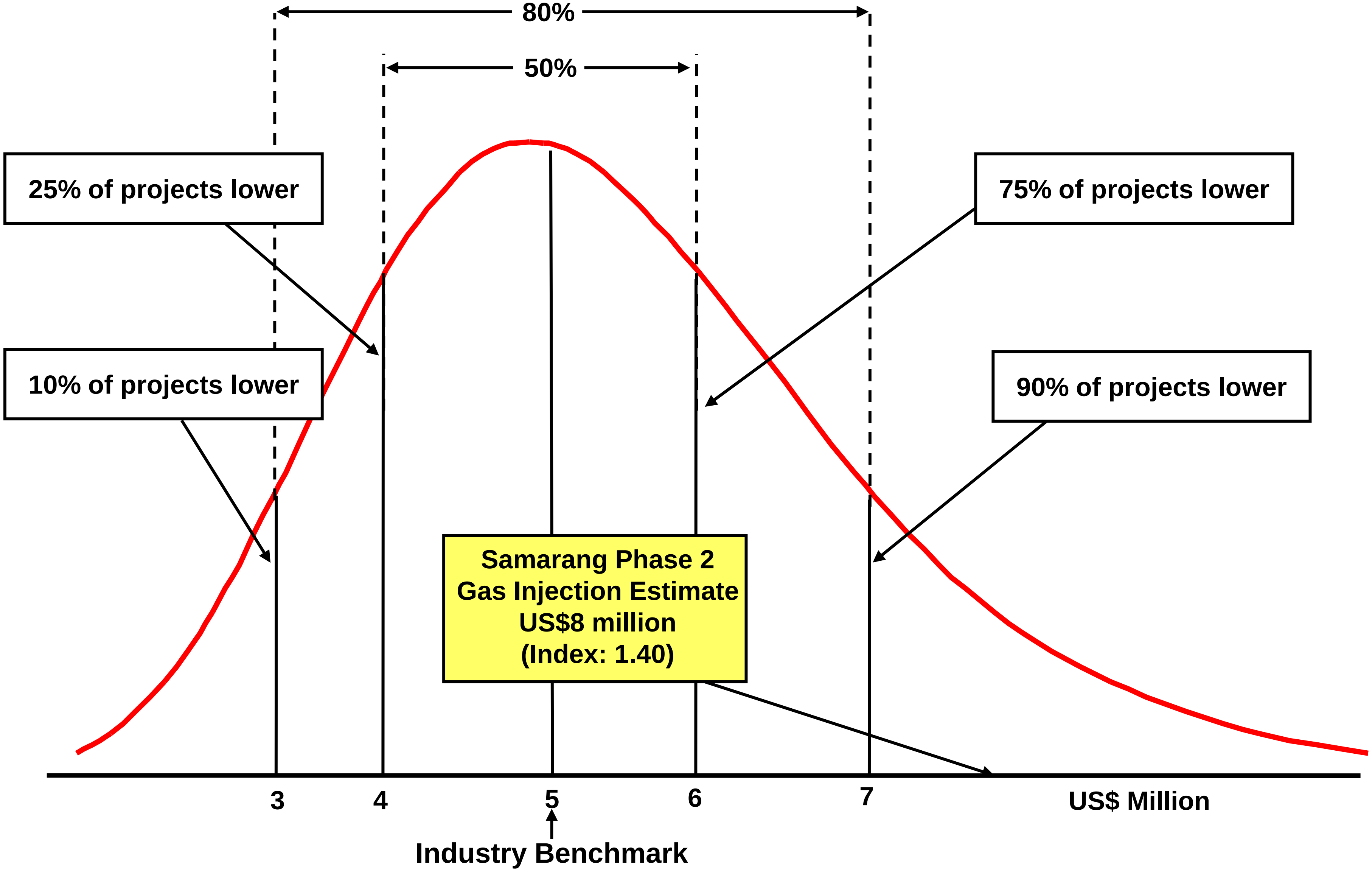
Pipeline Component Model

Gas Pipeline Estimate Is Comparable With Industry



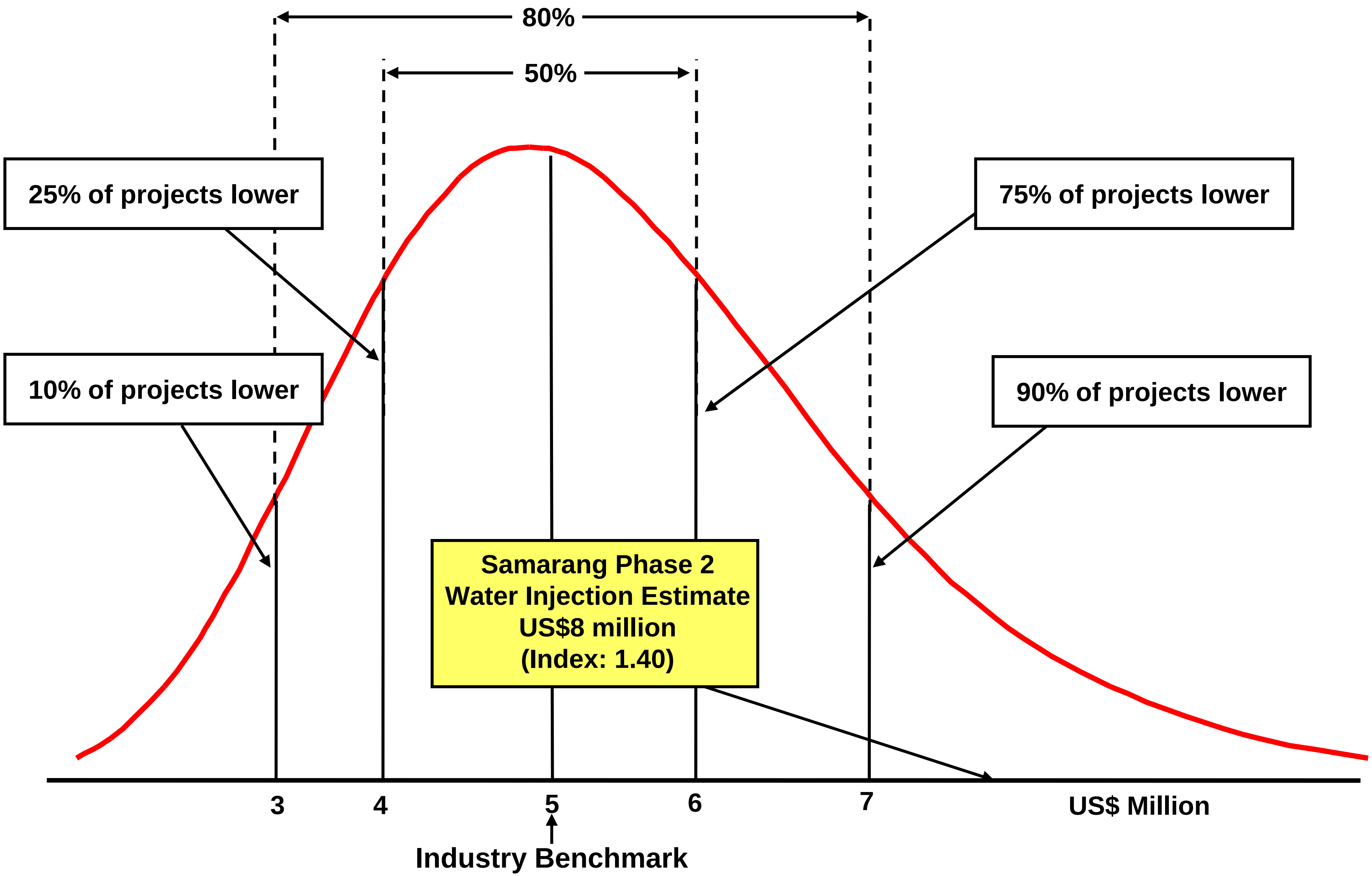
Pipeline Component Model

Gas Injection Estimate Is More Expensive Than Industry



Pipeline Component Model

Water Injection Estimate Is More Expensive Than Industry



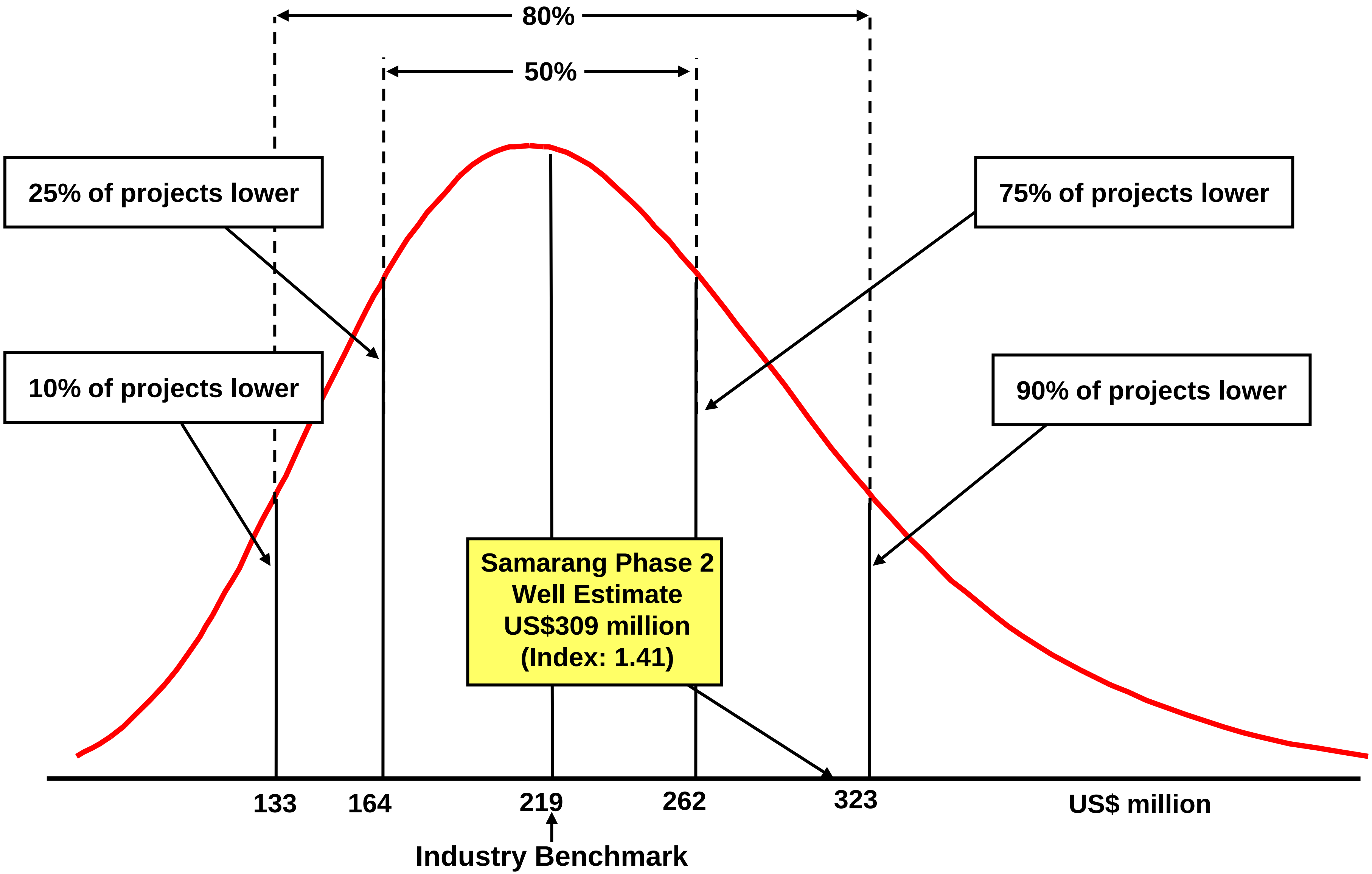
Cost Analysis
Overall Samarang Phase 2 Facilities

Outcome Metric	Samarang Phase 2	Global Average
SMG-AA CPP (Index)	321 (1.02)	317 (1.00)
SMJT-AA WHP (Index)	34 (0.52)	61 (1.00)
SMW-B (Index)	98 (0.71)	138 (1.00)
Pipeline – Gas infield (Index)	9 (0.90)	10 (1.00)
Pipeline – Gas Injection (Index)	8 (1.40)	5 (1.00)
Pipeline – Water Injection (Index)	8 (1.40)	5 (1.00)
Total Facilities (Index)*	478 (0.89)	536 (1.00)

***Note: Excluding revamp costs of US$92 million**

Well Construction Component Model

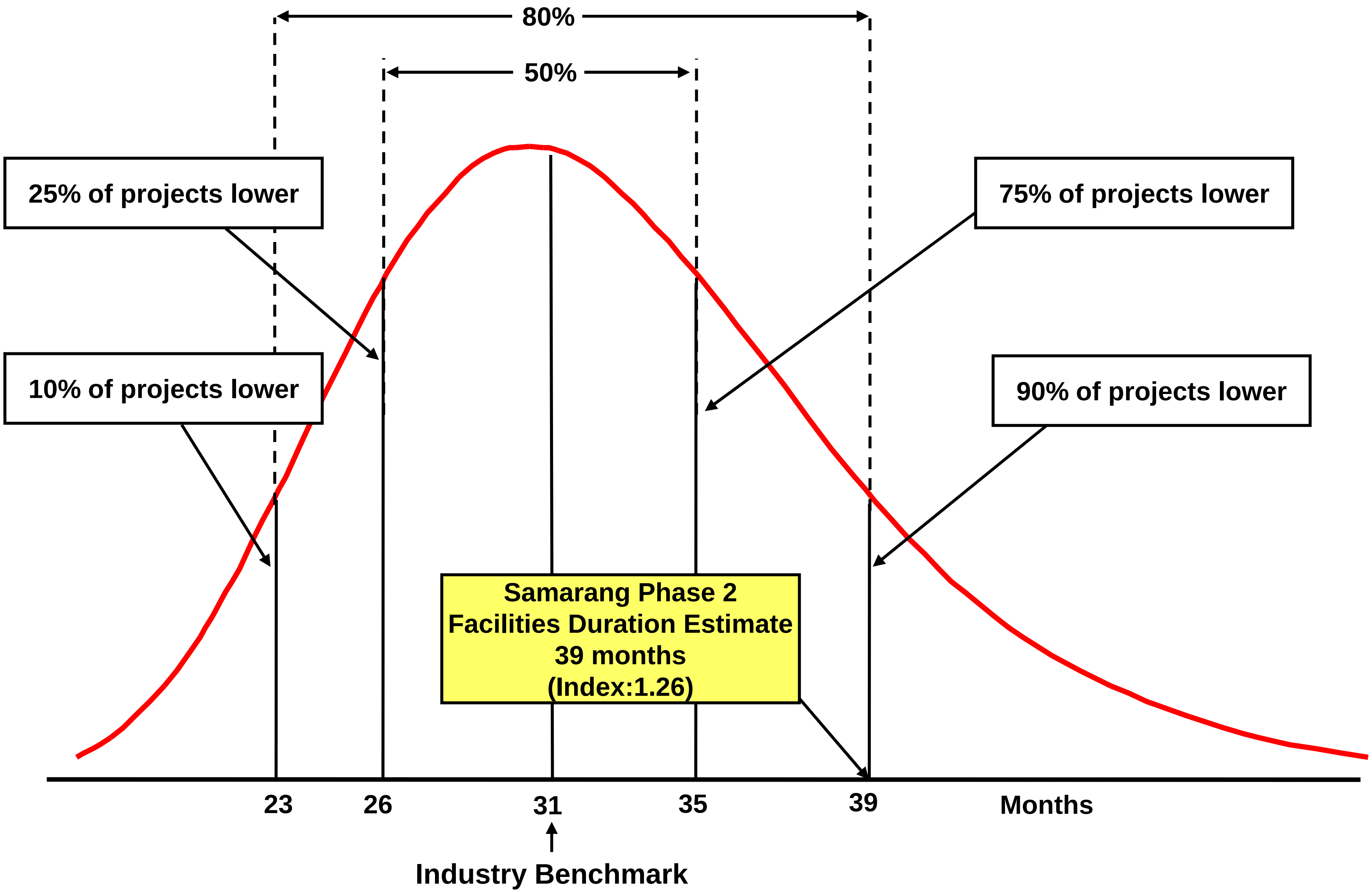
Phase 2 Cost Estimate Is Higher Than Industry



Cost Analysis Summary
Samarang Project Phase 2

- **Asset $/BOE is higher than industry average**
  - **Recovery per well lower than average**
  - **Phase 2 depletion plan requires high CAPEX for gas and water injectors**
- **Overall facilities cost is competitive**
  - **SMG-AA is comparable with industry average**
  - **SMJT-AA, SMW-B and gas pipeline estimates are aggressive**
  - **Gas and water injection pipelines are conservative**
- **Well construction costs higher than average project with similar well complexity**

Facilities Execution Duration Model
Phase 2 Much Slower Than Industry



Facilities Execution Schedule Analysis
Samarang Project Phase 2

Facilities' CAPEX (US$ million)	Detailed Engineering Start Date	FID Date	1st Oil Date	Samarang Phase 2 Execution Duration (months)	Industry Average (Months)	Top Quartile (Months)
570	November 2011	July 2011	October 2014	39	31	28

- **CPP Topside HUC: 11 Sept 2014**
- **SMJT-AA HUC: 5 July 2015**
- **SMW-B HUC: 5 Oct 2015**
- **Revamp HUC: 27 Nov 2015**

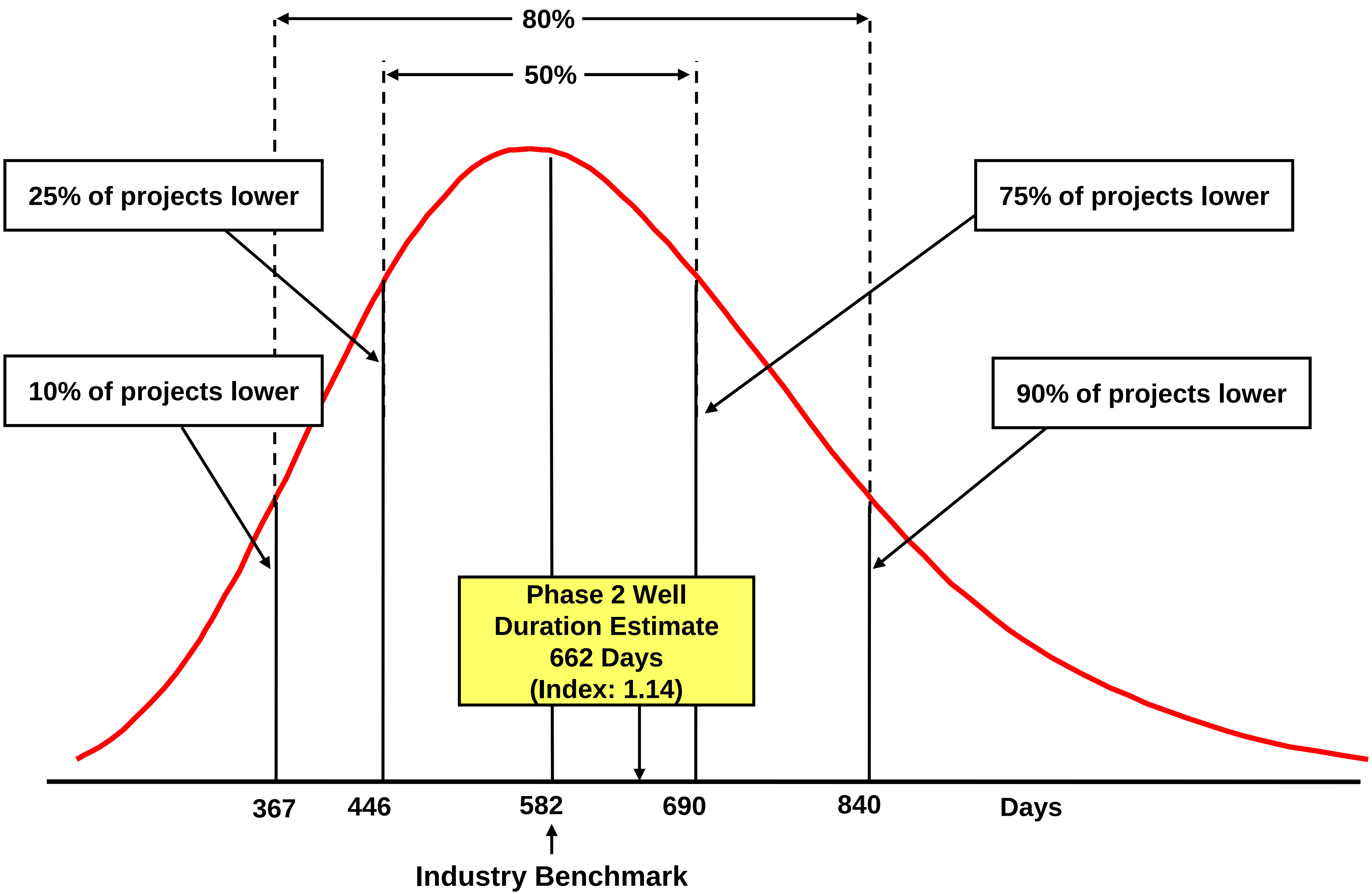
Infill Drilling:
7 Sept 2014 to 4 Aug 2015

Benchmark Assumptions:

- **Industry average duration based on facilities cost**
- **Execution duration is from detailed engineering to 1st hydrocarbon or mechanical completion**
- **Benchmark assumes industry average overlap of detailed engineering and fabrication (34 percent)**

Well Construction Duration Model

Samarang Phase 2 Is Slower Than Industry Average



Wells Schedule Analysis Summary

Samarang Project Phase 2

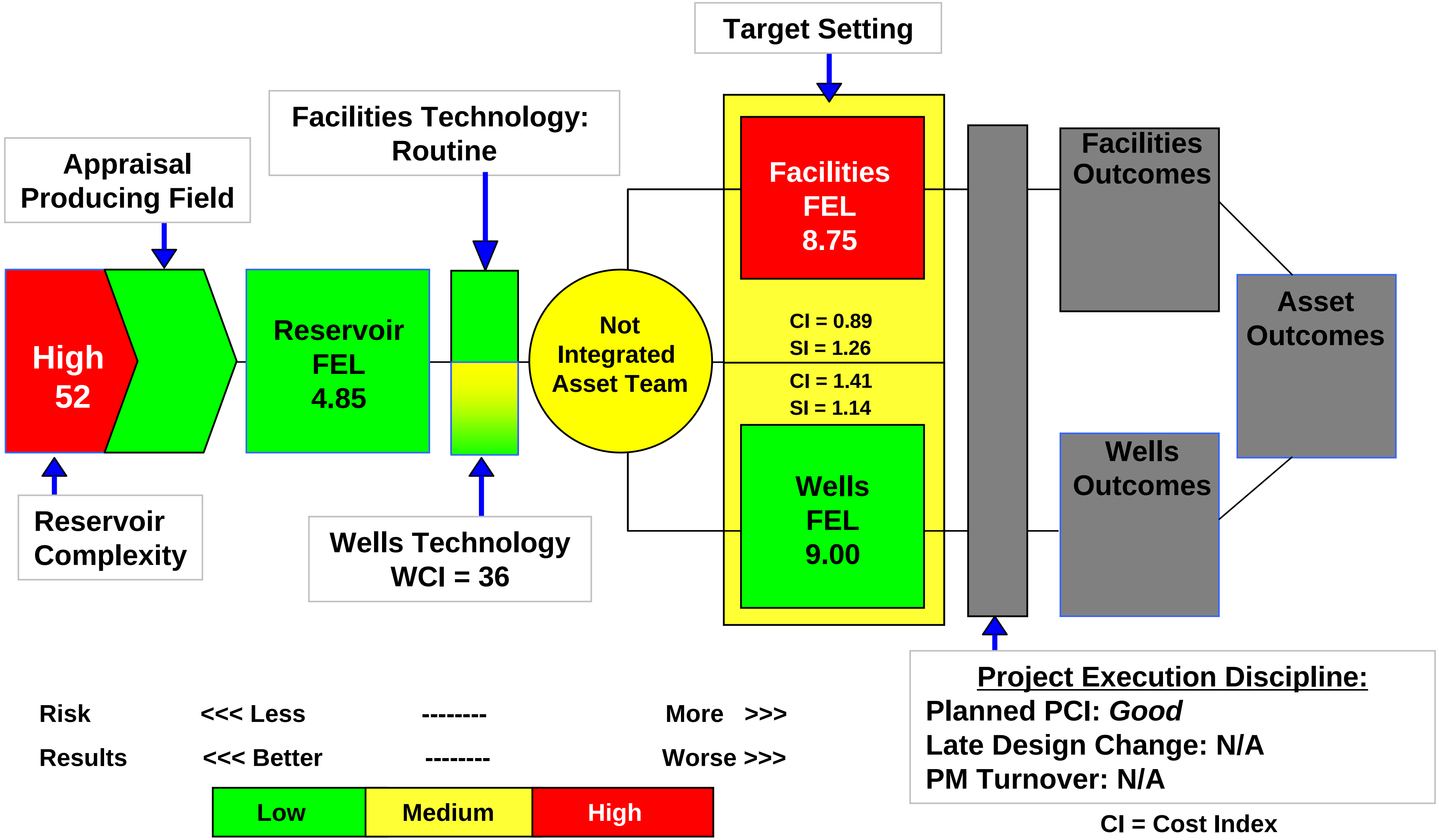
- **Well construction duration is slower than Industry**
  - **On average, Phase 2 will drill at a rate of 6.7 days/1,000 ft vs. 5.6 days/1,000 ft for comparison dataset[1]**
  - **Or 20 percent slower based on this comparison dataset**
    - **Which aligns with the well construction duration model**

Note:
[1] Comparison dataset consists of 12 projects with more than 120 wells in the wells program. 3 projects are in Asia Pacific

Outline

- **Key Message**
- **Project Background**
- **Basis of Comparison**
- **Practices and Drivers**
- **Targeted Outcomes**
- ***Conclusions – Phase 2***
- **Recommendations**

Summary of the Samarang Project Phase 2



CI = Cost Index
SI = Schedule Index
PDA = Production Attainment

Conclusions: Drivers and Practices
Samarang Project Phase 2

- **New technology applied – GASWAG EOR technique unproven in Industry and is a risk**
- **Reservoir and Wells FEL at *Optimal* level for this phase**
- **Facilities scope has major gap in PEP and schedule**
- ***Fair* TDI driven by lack of integrated team (i.e., missing full-time operations representative)**
- **Planned project controls aligned with Industry**

Conclusions: Targets

Phase 2 Cost Targets Mostly Competitive

- **Planned asset development cost/BOE is uncompetitive**
  - **Driven by low recovery/well given the EOR nature of project**
- **Overall facilities cost estimate is competitive**
  - **However, estimates for SMJT-AA, SMW-B and gas pipeline are highly aggressive**
  - **Water and gas injection pipelines are conservative**
  - **SMG-AA is competitive**
- **Drilling program more expensive than industry average for similar well complexity**

Outline

- **Key Message**
- **Project Background**
- **Basis of Comparison**
- **Practices and Drivers**
- **Targeted Outcomes**
- **Conclusions**
- ***Recommendations – Phase 2***

Recommendations (1)

Develop Detailed Impact Plan For Late EOR Inputs

- **Minimise effect of late changes from overlap of Phase 2 FEED and subsurface EOR analysis from Phase 1 core and other EOR inputs**
  - **Past projects that conducted subsurface and facilities work in parallel had late changes, driving cost growth and schedule slips**
  - **Team acknowledges changes in detailed engineering are inevitable given timing of core analysis and other EOR inputs**
  - **Therefore, team must develop a detailed contingency plan (scenario planning) of possible changes due to late EOR inputs from Phase 1 with cost, schedule, and production impacts**

Recommendations (2)

Define Measures of Success for GASWAG EOR

- **Team highly driven to implement GASWAG for Samarang field**
- **As GASWAG is new technology, team must develop measureable definition of success prior to start of FEED**
  - **Should include:**
    - > **Accounting for GASWAG EOR performance after startup**
    - > **Time by which GASWAG success must be shown**
    - > **Consequences if GASWAG is not successful**
  - **Definitions of success must be agreed by all stakeholders and management**

Recommendations (3)
Close Schedule Definition Gaps

- **Improve project schedule definition**
  - **Complete preparation of project schedule**
  - **Develop more details in platform revamp activities**
  - **Do critical path analysis**
- **Load schedule with critical resources prior to project authorisation to achieve a *Definitive* schedule**

Recommendations (4)

Carry Over Lessons From Drilling Phase 1

- **Similar to Phase 1, team drilling risks exist, especially for fault tracking drilling technique and K sands**
- **Team must carry over drilling lessons learned from Phase 1 to reduce risks for Phase 2**
- **Sufficient contingencies should be allocated to cover risks after incorporating lessons from Phase 1**

Independent Project Analysis, Inc.

Trung Ghi - tghi@ipaglobal.com

Level 1, 56 Burgundy Street

Heidelberg, Victoria 3084

+61-3-9458-7315

Phase 1 Prospective and Phase 2 Pacesetter Evaluations of the Samarang Project

Prepared for PETRONAS

Prepared by
Adrian Kong and Trung Ghi

April 2010

FINAL

IPA INDEPENDENT PROJECT ANALYSIS, INC.