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Artificial Lift Management and Adoption on New Technologies and Digitalization

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Artificial Lift in Malaysia

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Artificial Lift

Any system that adds energy to the fluid column in a wellbore with the objective of initiating and improving production from the well

Artificial-lift systems use various type of operating principles. In the process, the pressure in the bottom of the well is reduced (drawdown) and the reservoir fluids can flow to the well.

In Malaysia, 2 type of artificial lift system can be found

- Gas lift
- Electrical Submersible Pump (ESP)

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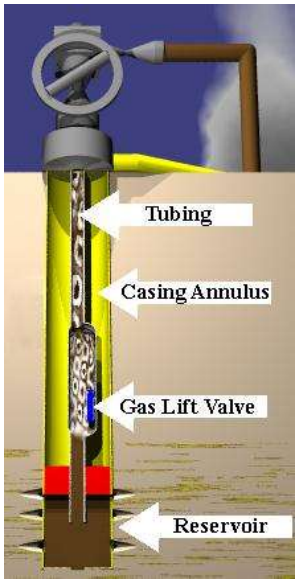
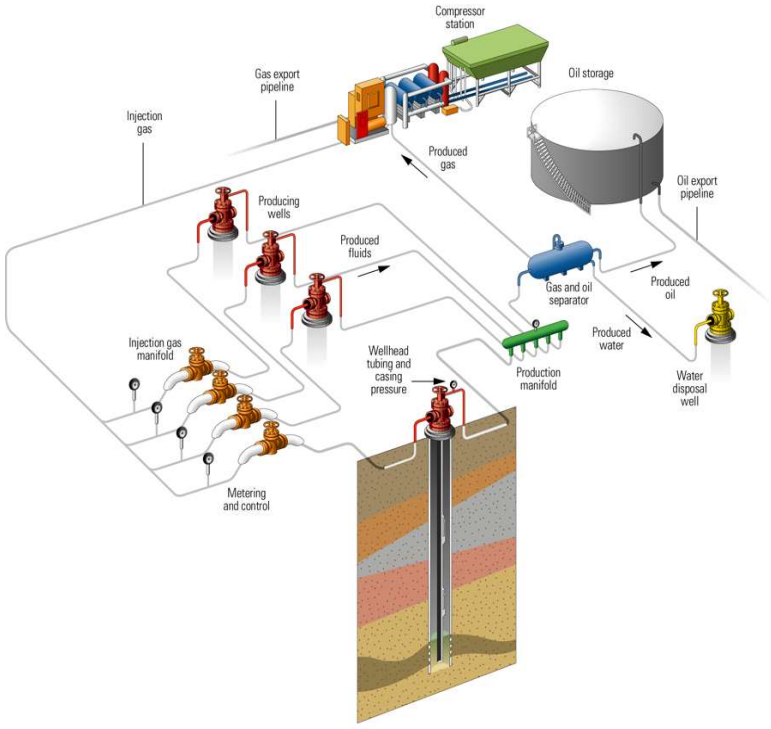
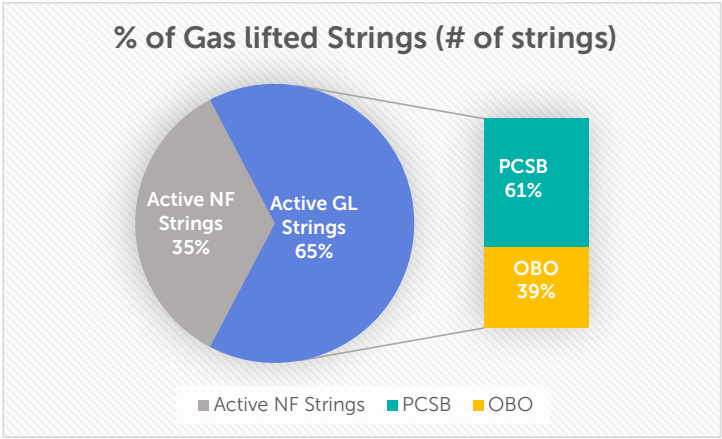
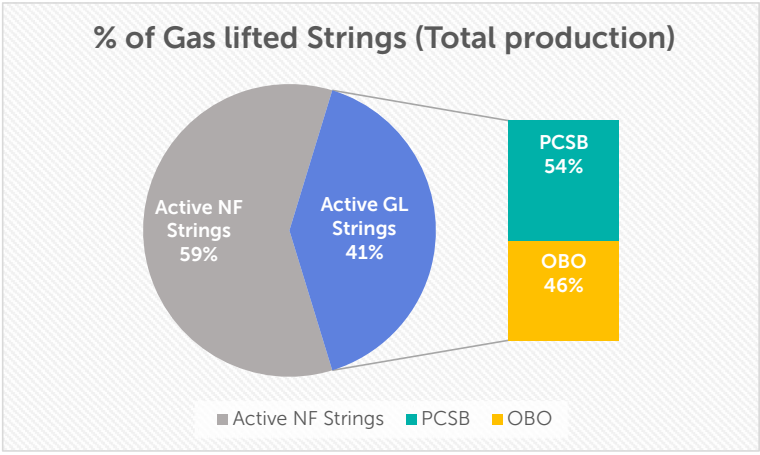
Gas Lift Overview

There are total of about 900++ gas-lifted strings (65%) contributing to 41% of total Malaysia production. Currently, we are optimizing around 5% of total gas lifted production per year









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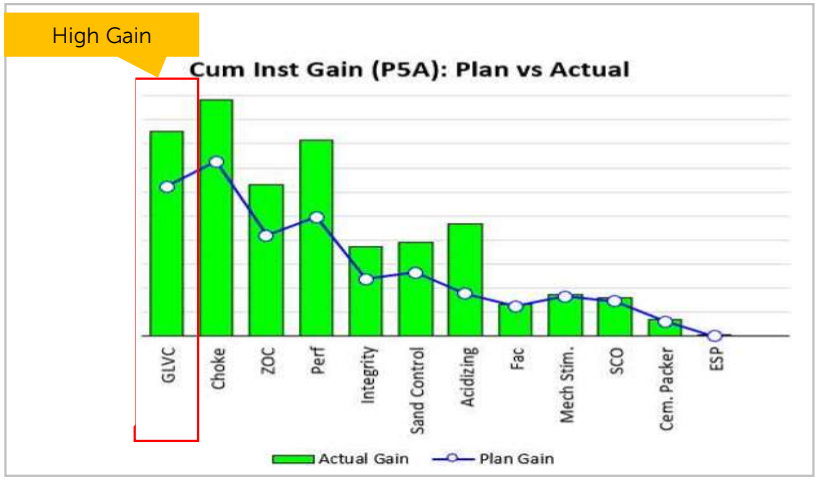
GLOP has the lowest UEC

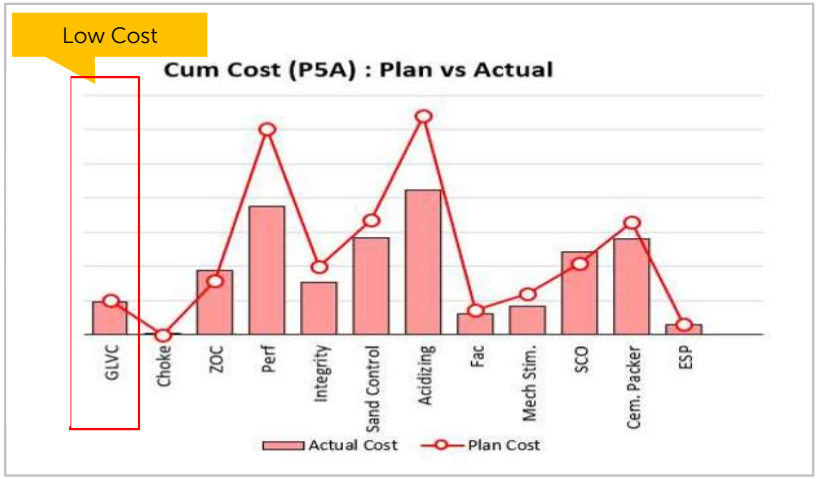
With the current unprecedented and challenging times, GLOP is the most cost effective and impactful option for production enhancement with the highest cumulative gain and lowest Unit Enhancement Cost (UEC)

Based on the graphs trending by year 2016-2019, GLVC/GLOP is one of the top 2 activities in giving highest gain & lowest UEC

High Gain



Low Cost



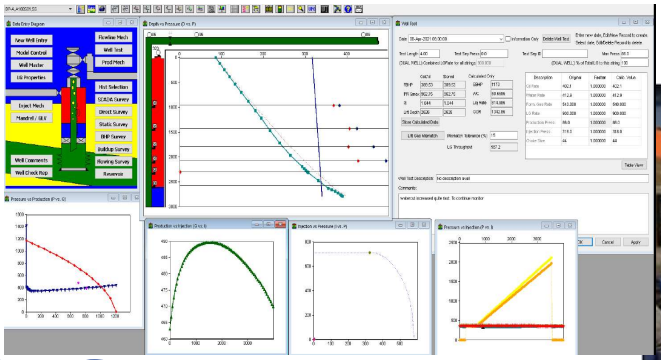
CO2 Well Tracer Technology

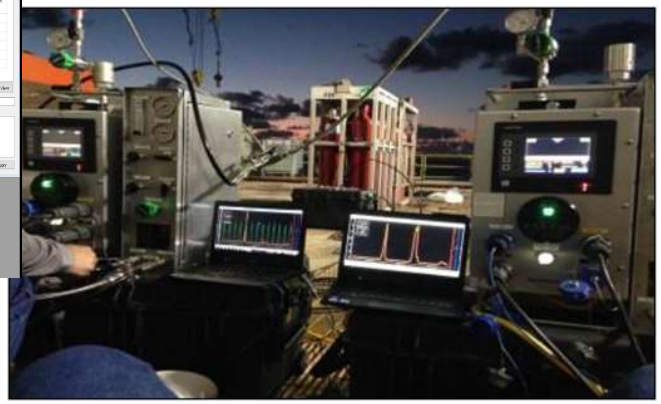
The CO_2 tracer technology, allow to monitor the number of injection points in the well.

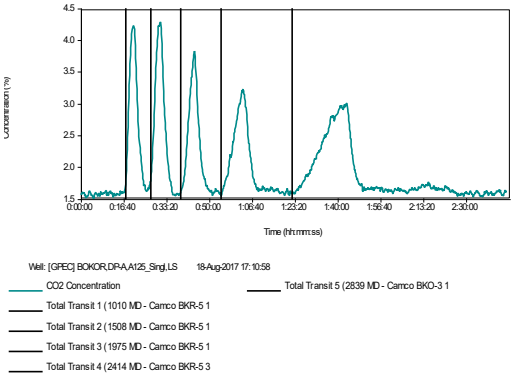
The injection points for the well can be either via the gaslift valves or also tubing leaks. This technology also allows an accurate measurement of the amount of lift gas which enters the tubing via each injection point.

This technology can be used as an alternate to FGS for the following advantages:

- Minimum equipment hook-up and no need to shut-in or choke the well, thus minimize production deferment.
- No wireline tools introduced into the wellbore, thus eliminate well intervention risk.
- Suitable for wells where a FGS is not possible due to well slugging, significantly deviated or with downhole obstruction.
- Possible to run survey on dual string wells to determine the gaslift split factor of a dual completion
- Possible to determine exactly how much gas is injected through each injection point of a well







Digital Intelligent Artificial Lift (DIAL)

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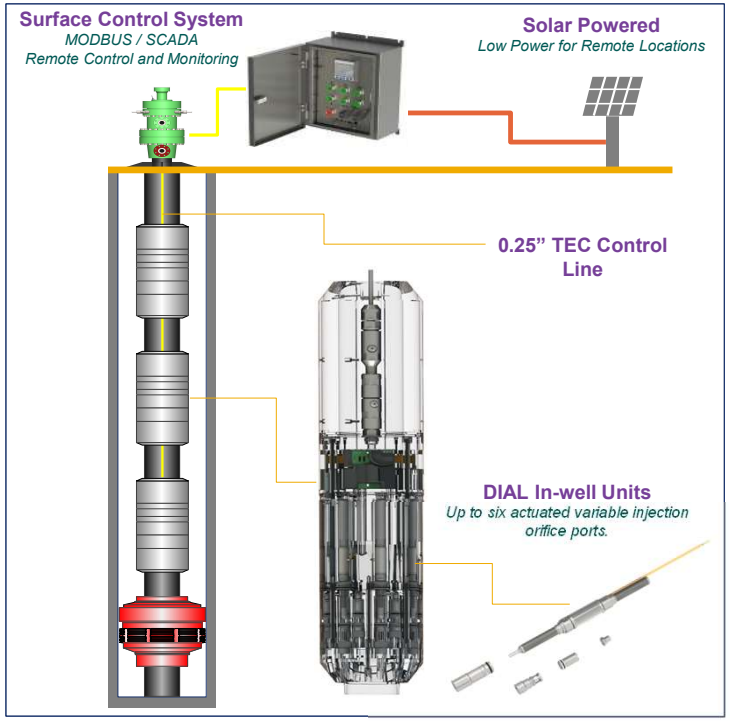
Tubing deployed DIAL units are strategically positioned in the well. They are connected by the TEC which provides power and comms. A surface control system allows local or remote actuation of the DIAL units to adjust injection rate and depth.

Features

- Variable orifice size at any depth
- Deeper injection
- No deviation limitation
- No well intervention required
- Pressure and temp data to surface
- Remote monitoring and control
- AI/automated gas lift production

Benefits

- Eliminate intervention
- Reduce OPEX
- Mitigate instabilities
- Enhance recoveries
- Optimize production
- Reduce HSE risk



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Digital Intelligent Artificial Lift (DIAL)

How the DIAL System Addresses the Challenges

Conventional Gas Lift Challenges

- Mechanically driven and sensitive to downhole pressure and temperature.
- Inability to change gas injection rate or depth without well intervention, typically resulting in a 10-20% under optimized state.
- Absence of in-well data to determine gas lift depth and multi-point injection.
- Difficult to determine actual performance vs well model.
- Deployment deviation limit of 60° for wireline access.

DIAL Production Optimization

- Digitally operated, integrating into the digital oilfield.
- Electronically operated from the surface, independent of well pressure and temperature.
- Actuator position sensing enabling operator the knowledge of injection depth and rate.
- Real time pressures and temperature monitoring within the well
- Interventionless technology, can be deployed at high well inclination.
- Multiple ports at each depth, combined with real-time data, eliminating multi-point injection and ensuring continuous production optimization without intervention.

DIAL Technology Adoption Journey

2017

DIAL introduction through PETRONAS Technology Hunt Workshop.

Screening for candidates through all Assets.

LOA issued for first pilot well.

2018

Dulang installation, failure investigation and joint SPE paper detailing lessons learned.

PETRONAS and MPM delegation visit Silverwell Houston facility.

PETRONAS approve continuation of multi-well pilot program.

2019

Letter of award issued for 5 well pilot program

2020

2 wells installation (dual and single), installed using 100% Malaysian crew due to COVID-19 restrictions.

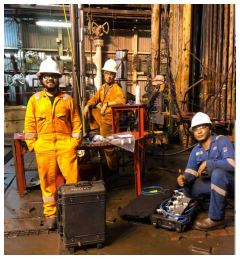
One of the long string experienced loss of comms due to TEC pinch during RIH. Iinvestigation concluded, and lessons learned applied on next wells.

Additional 1 well (dual) successfully installed without incident.

2021/2022

2 wells installation.

Wider field implementation.



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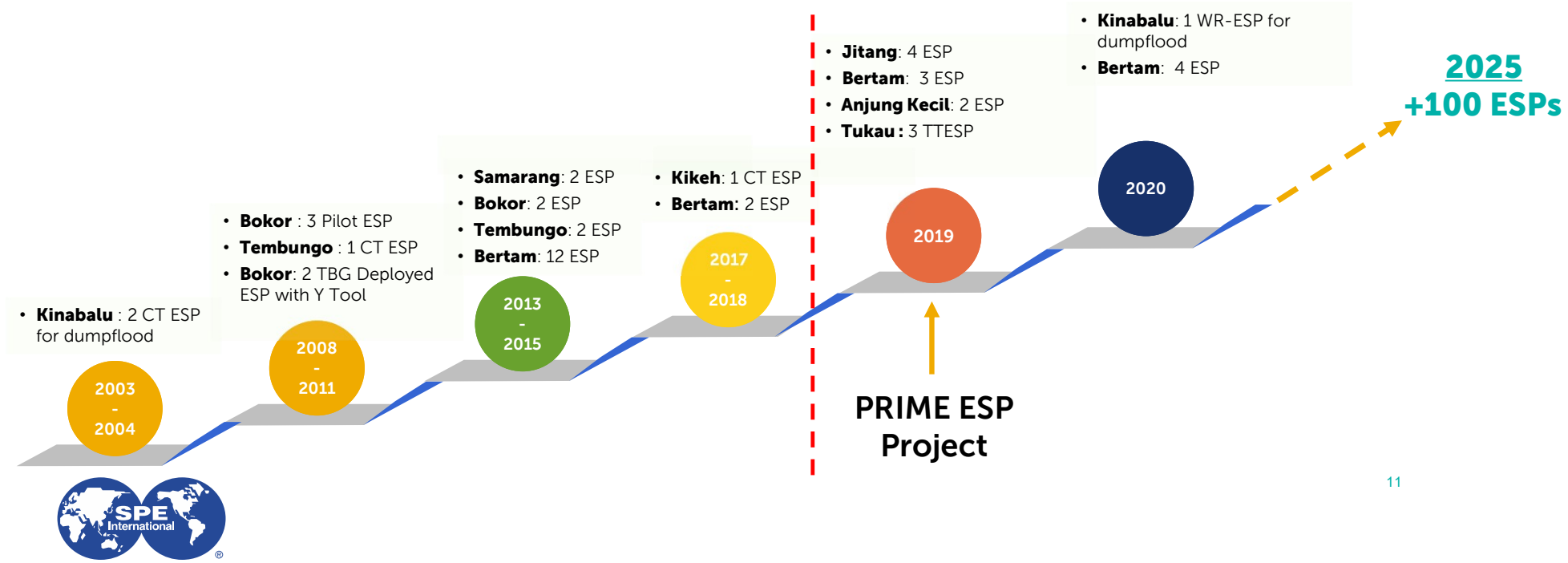
ESP Journey in Malaysia

42 ESP **installed** as of 2020

Average run time **> 4 years for Bokor & Bertam Fields**

12 ESP installed in **2019 (IPC, Vestigo, PCSB)**



Benchmarking with other location

- Regionally Indonesia and Thailand have a more developed ESP ecosystem to address their production constraints and field development requirements.
- Significant learnings and best practices has been captured from PERTAMINA and PTTEP.

PRIME Team

PRIME ESP initiative was established by MPM to fully capitalize on ESP Technology to enhance production & reserves monetization

2021-22 Key Deliverables

- Complete the ESP Feasibility Study for 5 key fields to mature ESP opportunity basket and recommend most cost-effective solution for ESP implementation.
- Establish ESP Integrated Contract as a key enabler to enhance ESP replication via more volume of work, lower cost and improved lifecycle efficiency.
- Pursue short term ESP candidate reactivation/implementation in

How to deliver 2021-22 targets?

The "PRIME" Team focus

To provide support and steer PACs for candidate selection and proposal maturation

To collaborate with Solution Partners to prepare techno-commercial feasible execution options

To support procurement and contracting strategy

Follow up on execution plans and results monitoring and evaluation

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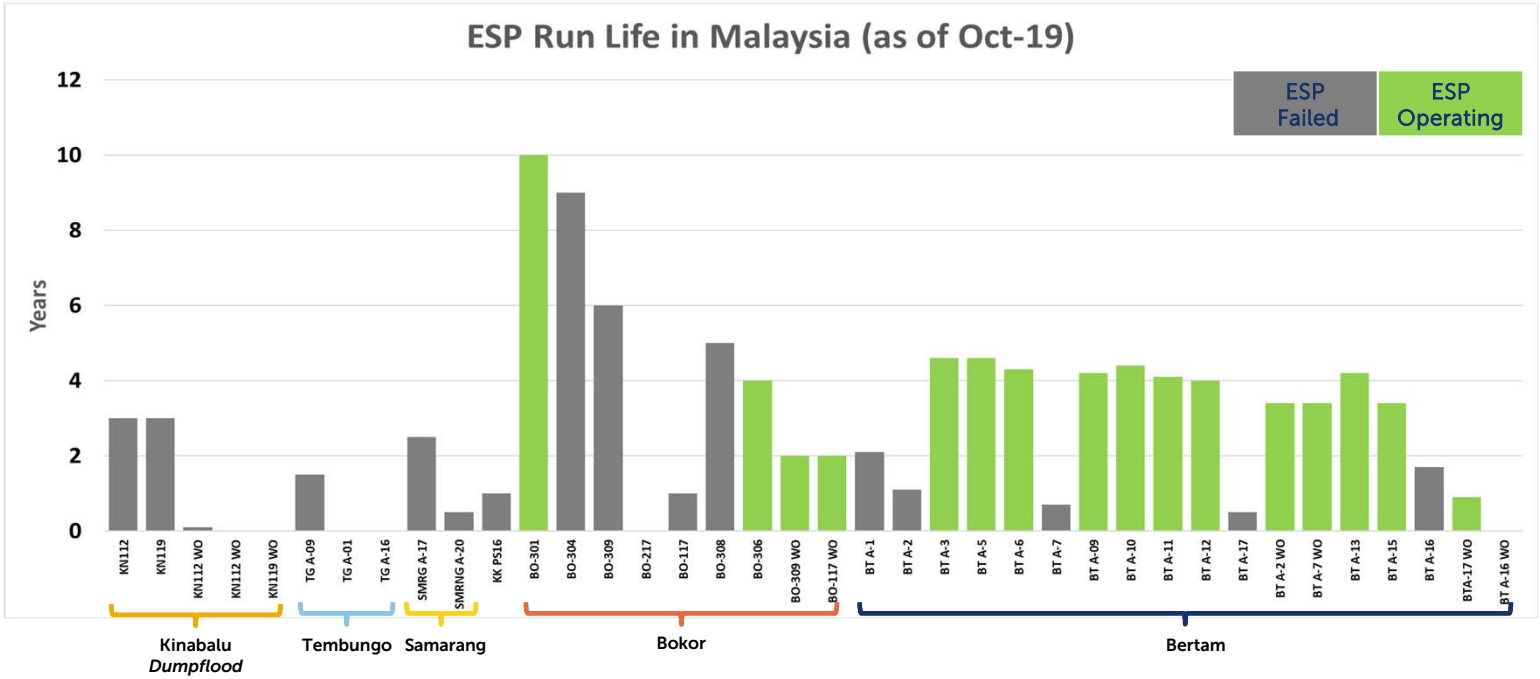
ESP performance



- Kinabalu, Tembungo, Samarang and Kikeh fields ESP run life was shorter mainly due to;
  - Lack of understanding of reservoir and fluid parameters
  - Complex ESP design

- Advancement in the ESP technology, lessons learnt and overall understanding of the candidate's selection have led to successful implementation in Bokor and Bertam fields.
  - Bokor field ESP applications run life is on average above 6 years
  - Bertam field ESP applications run life is on average above 3 years with 93% of wells still online

TTESP-CD Technology Invention

Development of technology involved an iterative process for technology and concept selection along with development of new deployment technique

1	Slim TTESP BHA & Anchor Packer	Development of slim OD ESP to fit thru 2-7/8”, 3-1/2” & 4-1/2” tubing is the heart of this technology, with capacities from 600 - 3800 blpd. Carried by power cable and hold by anchor packer with anti-torque and sting in/out multiple times
2	Live Well Intervention	Development of a Cable Termination Spool, Cable Hanger and penetrator system to enable live well deployment with API 6A compliance
3	De-risking Unproven Technology	Onshore Trial was done to de-risk the unproven and newly developed technology
4	Lightweight and low-cost deployment	Cable Deployment Unit (braided line) with modified winch, modified cable drum, standard mast and modified PCE to suit the application
5	API 14A certified Safety Valve	Insert Safety Valve (ISV) tailored for existing TRSSV with cable and certification to API14A & ISO 14310 V3

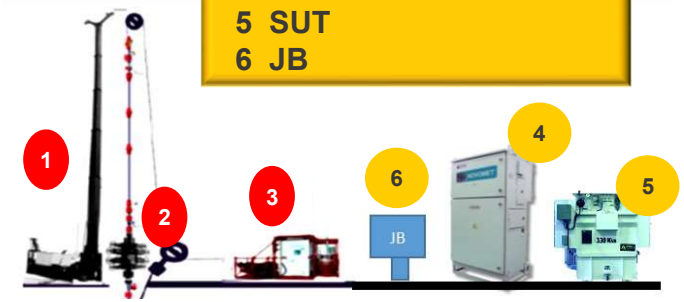
TTESP-CD System Schematic

INSTALLATION EQUIPMENT

1 Telescopic mast (90ft, 9tones)
2 Quad BOP
3 Power pack & Cable drum

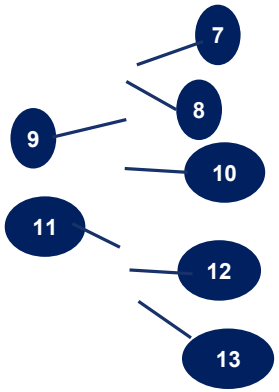
SURFACE EQUIPMENT

4 VSD
5 SUT
6 JB



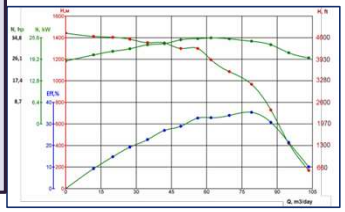
SUBSURFACE EQUIPMENT

7 Cable Termination Spool
8 Cable hanger
9 Cable Grapple, AU & Down-hole Penetrators
10 Insert safety valve
11 Cable clutch
12 TTESP BHA
13 Anchor packer



TTESP Technology Innovations are:

1. Anchor packer & stinger
2. TTESP DHA
3. Power cable & clutch
4. Insert safety valve
5. Cable termination spool & cable hanger
6. Deployment & stack up equipment

Pump OD	2.17“, 2.72”, 3.19”
Motor	Permanent Magnet Motor Speed: 8500 RPM, 4 Poles
Operating Temperature	Up to 300 ºF
Operating Liq Rate Range	600 – 3800 blpd
Gas Handling	Via AGH up to 40% GVF
Pump Performance Curve	

Thank you for your passion!