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Society of Petroleum Engineers

Gas Field Development and Production – State of Play

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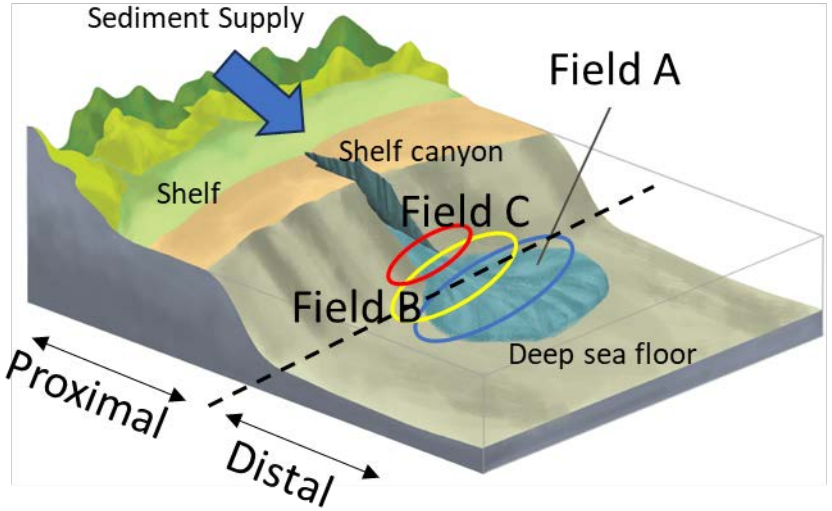
Successful Transformation Of A Deepwater Greenfield Development Plan From Negative Economic Project To Highly Profitable Venture Through Integrated Multidisciplinary FDP Development Strategy Revisit And Optimization: A Case Study

M Iman Mostaffa

PETRONAS Carigali Sdn Bhd

Field Background



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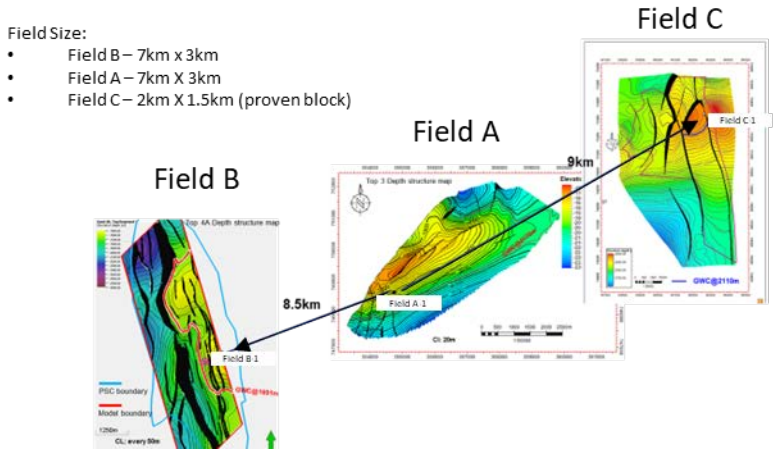
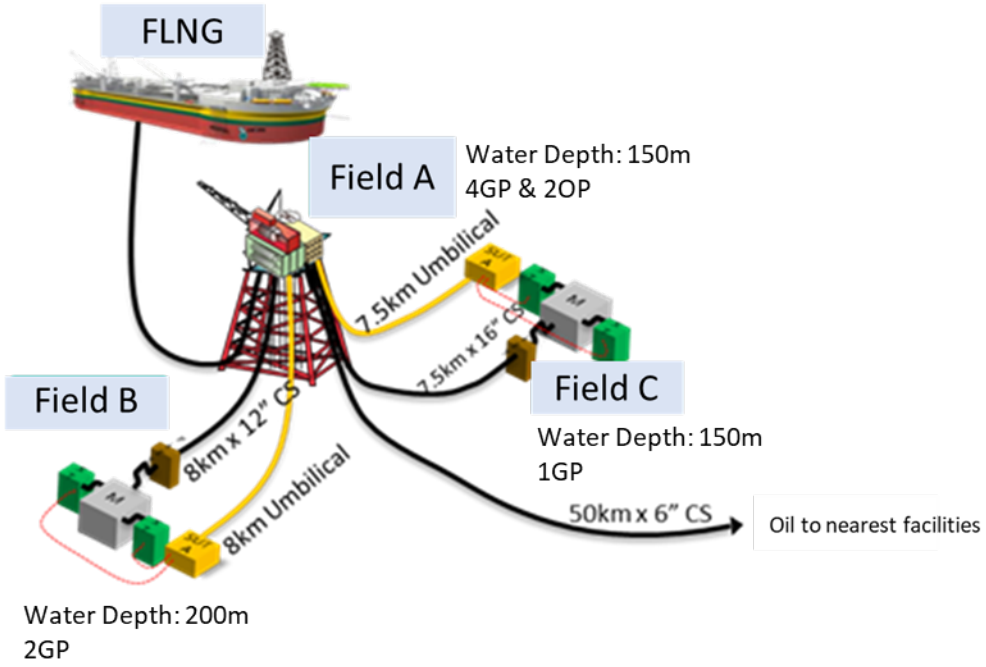
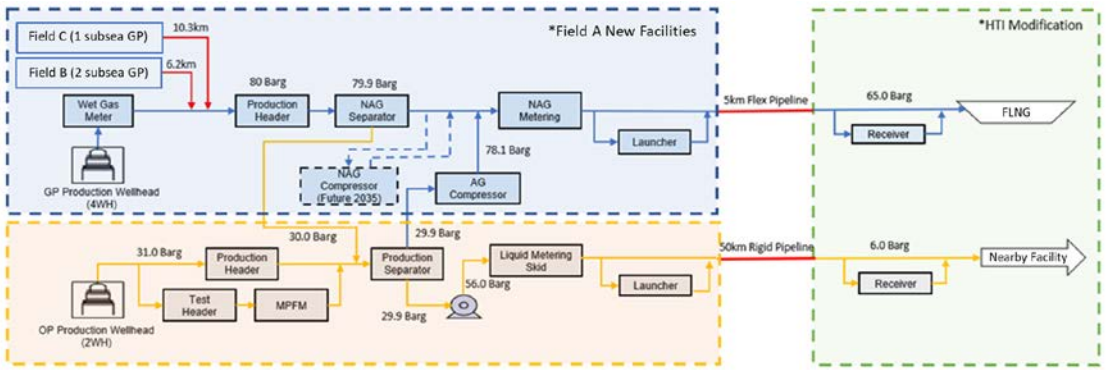


- Located offshore NW of Sabah, with water depth of 150-200m
- Geological setting - Turbidite Sandstone reservoirs; channel complex within proximal to distal basin floor

Field	Field A	Field B	Field C
TOTAL GAS IIP (BSCF)	~ 800	~ 200	~ 80
STOIIP (MMSTB)	~ 20	-	~ 4
Res Thickness (m)	6.8 - 35	14 - 42	11 - 23
Porosity	0.17 – 0.23	0.23 – 0.28	0.20 – 0.24
Permeability (mD)	100 - 600	50 - 285	250 - 580
Res. Press (psia) & Temp (F)	3400 – 4100 psia 202 – 239F	~3450psia ~175F	3500 – 3800 psia 197 – 207F

Problem Statement – The Why?





- Initial evacuation route for NAG is FLNG and Oil to the nearest facilities
- Proposed full field development concept: CPP at Field A, and Subsea completion for Field B & C
- Gas commitment: 200 MMscf/day for 8 years
- However, **project economics is negative** due to high development costs
- Top risk & uncertainties:
  i. Change in evacuation route due to competing domestic demand vs FLNG
  ii. Poor seismic quality below shallow gas cap
  iii. Structure uncertainty
  iv. Challenging economics

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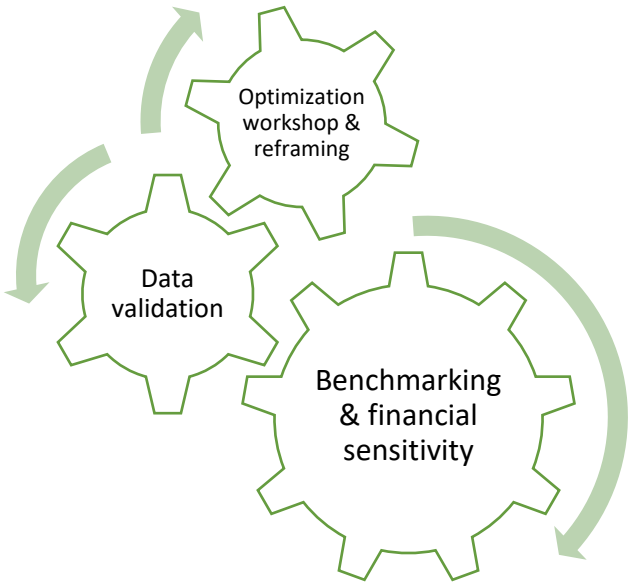
FDP Strategy – The How?

Drivers	Input	Detail Technical Analysis	Tactical Plan
Gas security of supply		Seismic Reprocessing	Reduce subsurface risk & uncertainties
Risk & Uncertainties management		Project Phasing Optimization	Phased field development and oil monetization
Optimize development		Well count optimization	Optimize development, maximize recovery
		Facilities design optimization	Reduce platform tonnage & lean processing facilities
		Economic fiscal improvement	PSC and gas price negotiation, change in gas evacuation route

Collaborative & Integrated Approach Resulted In Achieving Robust Project Economics

- Seismic Reprocessing & Re-interpretation
- Address risk of shallow gas
- Reduce geological uncertainty (sand distribution, fault continuity)

- Optimize field phasing development to accelerate First Gas Delivery
- RMP optimization to address water production
- Well count optimization

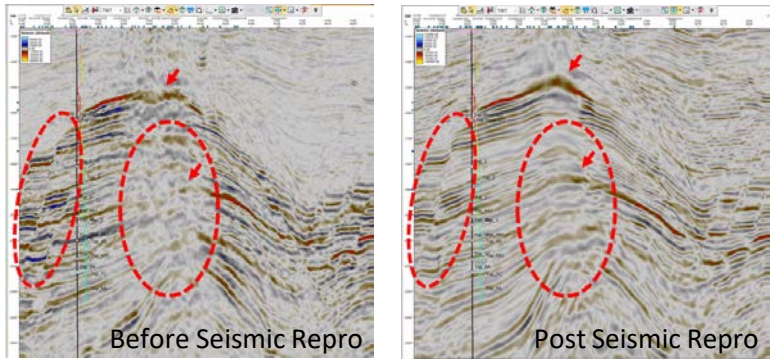
- Incorporate STMZ for cost effective well completion
- Optimize conductor casing size
- Offline unloading strategy
- Fit for purpose completion design

- Conducted Basic Engineering Design for simplification of topside process
- Optimize power generation to green energy
- Leverage industry design on similar facilities

- Re-negotiate PSC terms
- Evaluate possible evacuation route to domestic market
- Collaborate with host government in securing a favorable gas price

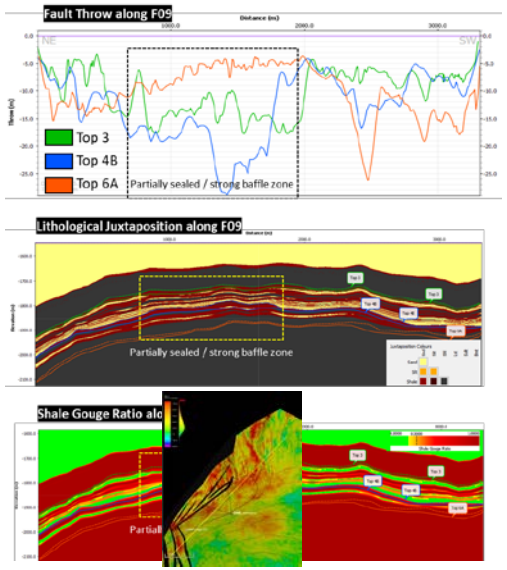
Subsurface Technical Studies

3D Seismic Reprocessing

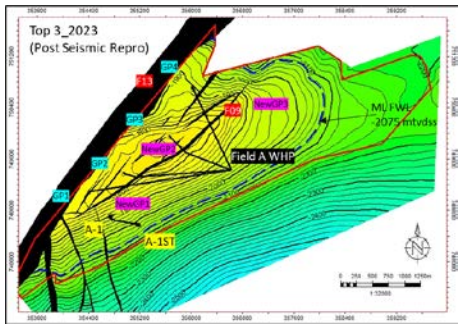


- Seismic reprocessing provides upliftment in seismic continuity and observed cleaner seismic image and sharper fault definition

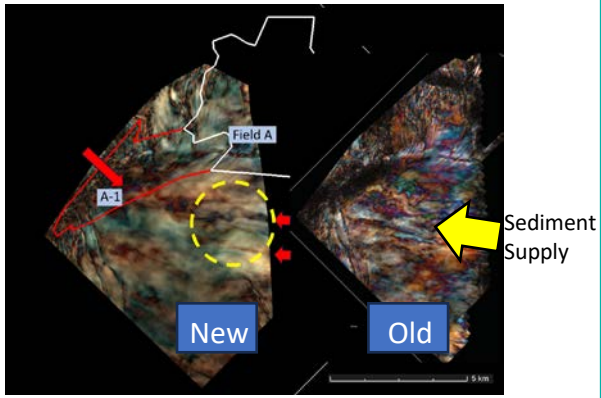
Fault Seal Analysis



- Fault Seal Analysis provides insight on fault location and fault transmissibility ultimately provide input for optimized well placement



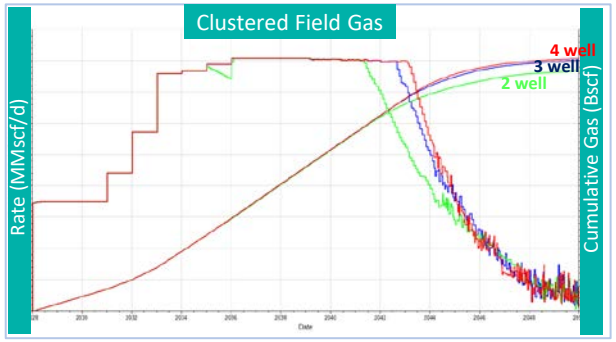
Spectral Decomposition



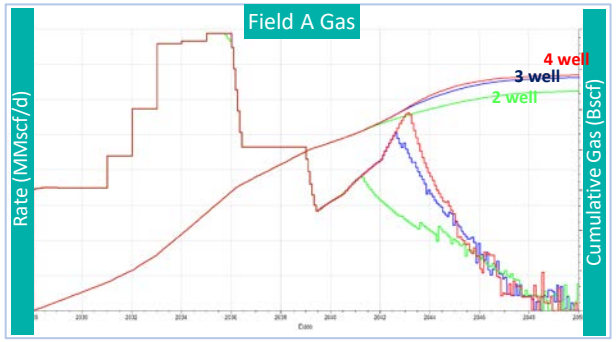
- Spectral decomposition show comparable channel trend to reconfirm geological understanding

Dynamic Simulation Sensitivity

- Field sequencing optimization to evaluate maximum spacing between fields to maintain plateau rates (Field A > Field B > Field C)
- Well count optimization in Field A P50 Case shows only ~1% volume reduction for 3 vs 4 wells recovery

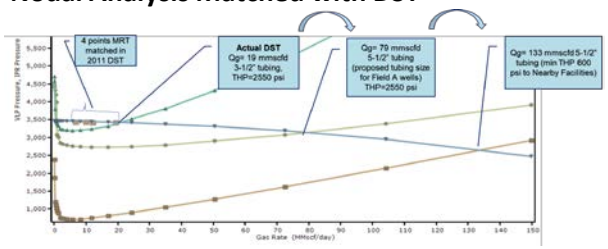


Clustered Field Production Profile (Field A > Field B > Field C)



Field A Production Profile

Nodal Analysis Matched with DST



- Tubing size selection to based on required rate and productivity to optimize well cost

Commercial Strategy and Facilities Study

Key Commercial Strategy

- Identify gas demand in domestic market which requires early monetization and providing security of supply for local market
- Evaluate value for oil monetization thru financial sensitivity analysis

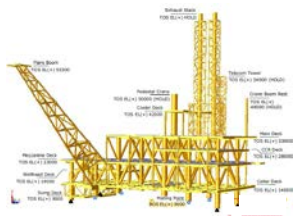
- Negotiated with Host Authority Government to change of the evacuation from FLNG to support domestic demand center
- Reduced demand to 150 MMscf/d allows longer plateau

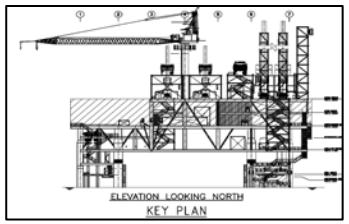
- PSC Term re-negotiation and secure favorable gas price

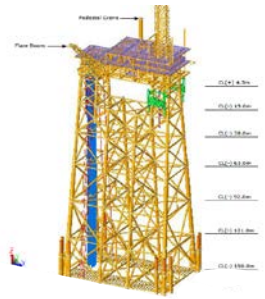
Basic Engineering Design

- Platform design re-evaluated to cater new development strategy (Mini CPP > WHP)

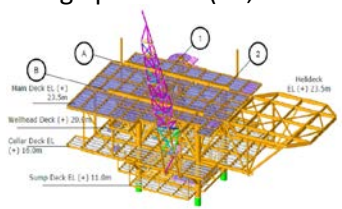
Initial Design (~7,700 MT)

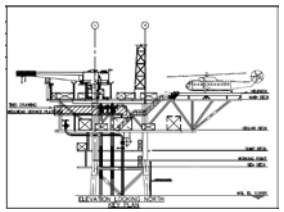




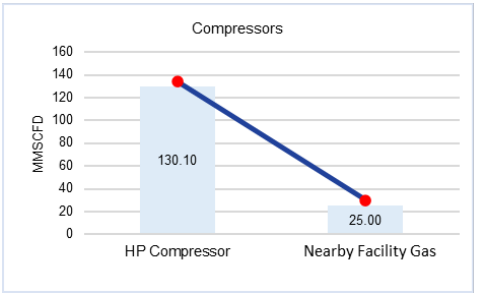


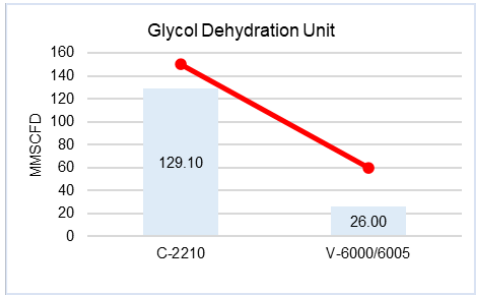
Design post BED (~1,100 MT)



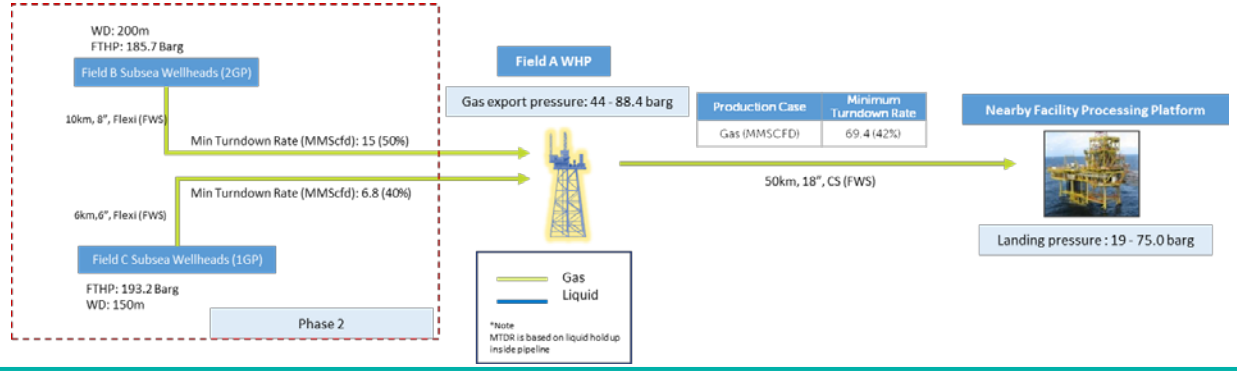


Field A WHP	
Design Capacity	165 MMSCFD
Facilities	• 3 Wellheads Gas Producer • Offline Well Unloading • FWS Production Export to Nearby Facility Hub
Utilities	• Power Generation System • Diesel System • Vent system • N2 system (portable) • Potable Water System • Chemical Injection (Methanol (start-up), Corrosion Inhibitor, Kinetic Hydrate Inhibitor (KHI), Biocide)
Power Generation	• Solar Hybrid Wind Turbine System (SHWT) • Solar Power System (4kW). Peak Load is 3.1kW • Diesel Engine Generator (60kW)
Metering Type	• Operational Meter
Control & Safeguarding	DCS, SIS, FGS Remote Autonomous Operation (RAO)



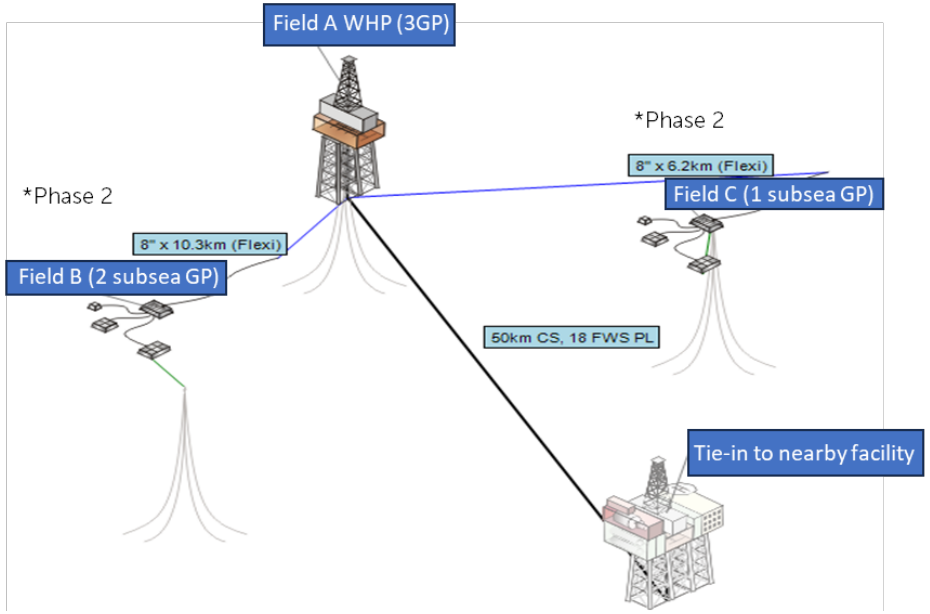


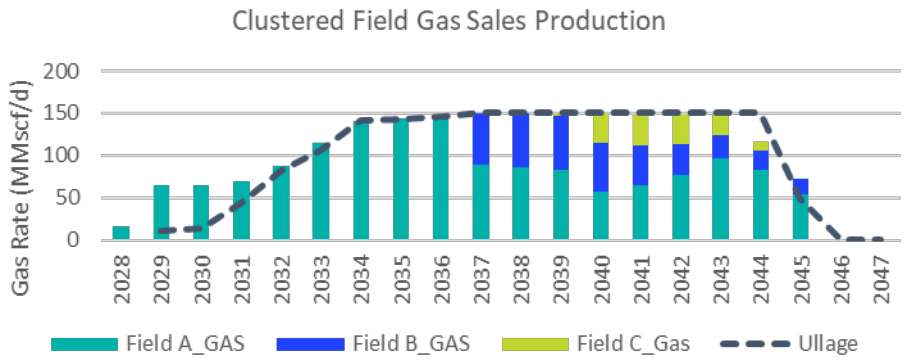
- Optimize pipeline hydraulics to FWS at Nearby Facility

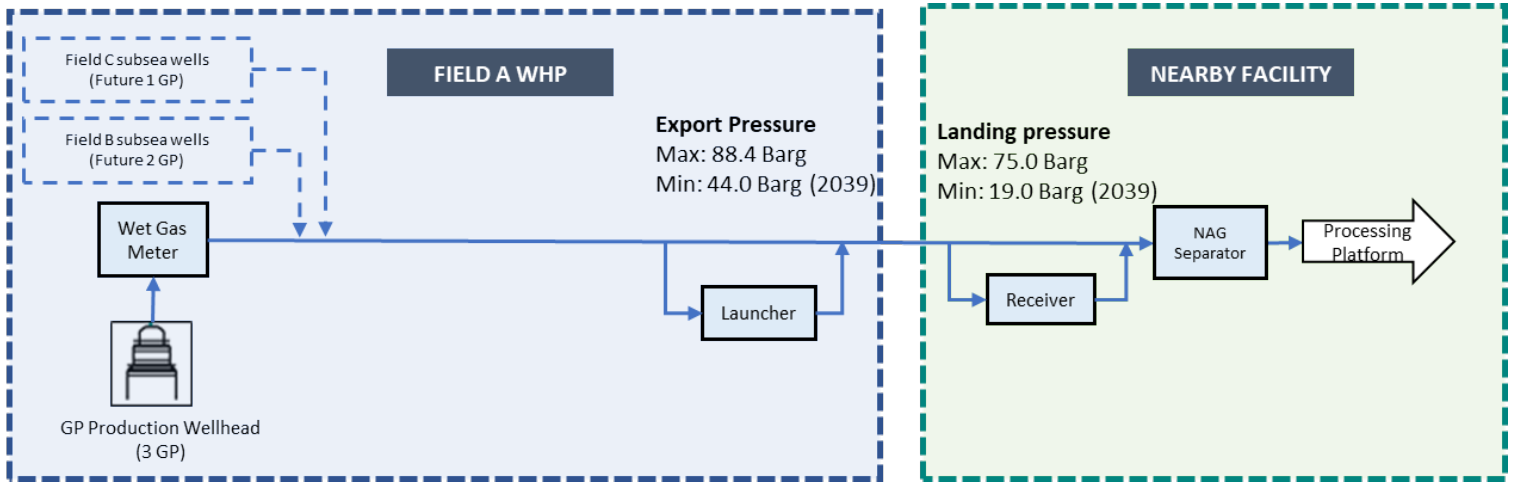


- Adequacy check at Nearby Facility gas handling capacity was completed to ensure robustness of the engineering study

Results







- The FDP resulted into phased gas field development
- Conversion CPP to WHP with lean processing facilities
- Field A well count optimization from 4 GP & 2 OP to only 3 GP with only 1% volume difference
- Oil to be developed using existing facilities when gas depleted
- Negotiated for earlier monetization to local market demand with better gas price
- Project economics turn from negative to positive

Conclusion

The **successful transformation** of this greenfield development plan from a negative economic project to a highly profitable venture stands as a testament to the **necessity of holistic interdisciplinary optimization** strategies, careful planning, risk mitigation, and collaborative stakeholder engagement.

Appreciation

Champion of Integrated Collaborators

- M Hafizuddin B M Nor
- Afiq A Hamid
- Zairi B A Kadir
- M Muzzamil B Sahjamal
- Georghious Dorou Papapetrou
- Shukri B Ismail
- Dzulfadly B Johare
- W Fatimah Bt W Shamshudhin
- Arie Purba Tata
- M Zaid M Yusoof
- Nadirah Bt Khairul Anuar
- Shazana Sofia Bt Mustapa
- M Nasrullah Annuar
- Muralithran Balakrisnan – Ts
- Muhamad Amirushah B Zakaria
- Siti Shafikah Bt Md Daud
- Adrina Puteri M Salleh
- Yusuf Theo Lebang
- Siti Zulaikha Bt Mohammad
- Aizuddin B Khalid
- Tg Rasidi B Tg Othman