# Power-Efficient Pump Optimisation and Production Assurance.

## Reducing Power Demand and Carbon Emissions while Maintaining Production.

**DEVEX 2025**

**Presented By**:

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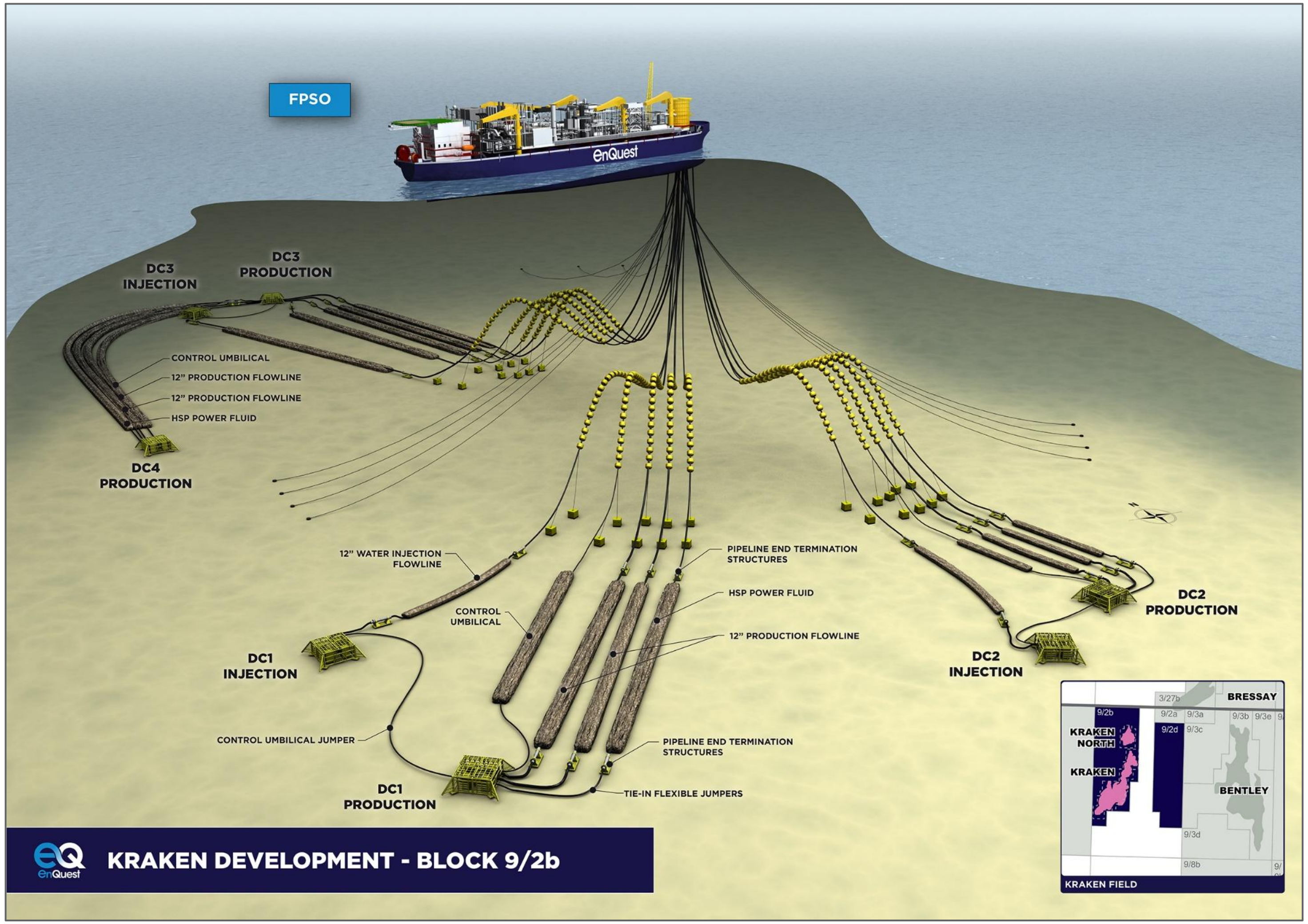
# Agenda

- Overview of the Kraken Fields
- Production and Injection Operation
- Opportunity Identification
- Production and Operational Parameter Evaluation
- Pump-Optimisation Workflow
- Operating Point Evolution
- Results

# Overview of Kraken Field




- Heavy oil subsea development approximately 400km NE of Aberdeen.
- Kraken and Kraken North shallow fields.
- 4 subsea drill centres tied back to the Kraken FPSO.
- Downhole Hydraulic Submersible Pumps (HSPs) provide artificial lift.
- Water Injection for pressure support and sweep.
- First Oil in June 2017.
- EnQuest (Operator): 70.5%, Waldorf UK: 29.5%

# Production and Injection Operation

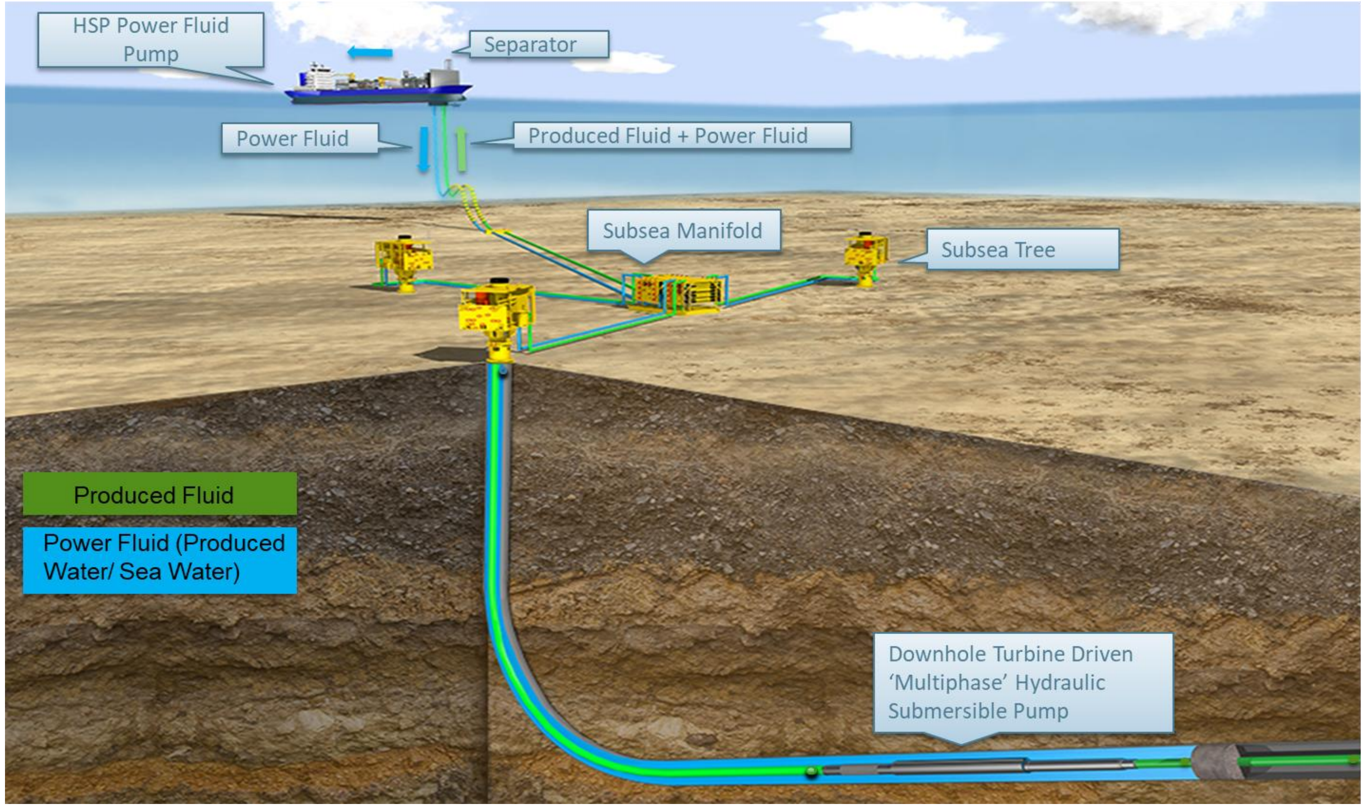
The Kraken Heavy Oil Field utilises two main topside pump units handling 450Mbwpd:

- **Power Water Pumps**

Deliver high-pressured power water (>300bar) to the downhole HSPs in 14 horizontal producer wells to produce viscous hydrocarbons to the surface and ensure flow assurance in the flowlines.

- **Water Injection Pumps**

Deliver (>70 bar) treated produced water and lifted seawater which is discharged for injection across the field through 12 injector wells.




The field runs on a closed-loop system where produced water is re-injected or used as power water to run the downhole HSPs. If required, seawater is lifted, treated, and fed-forward into the system to provide additional water for injection or artificial lift.

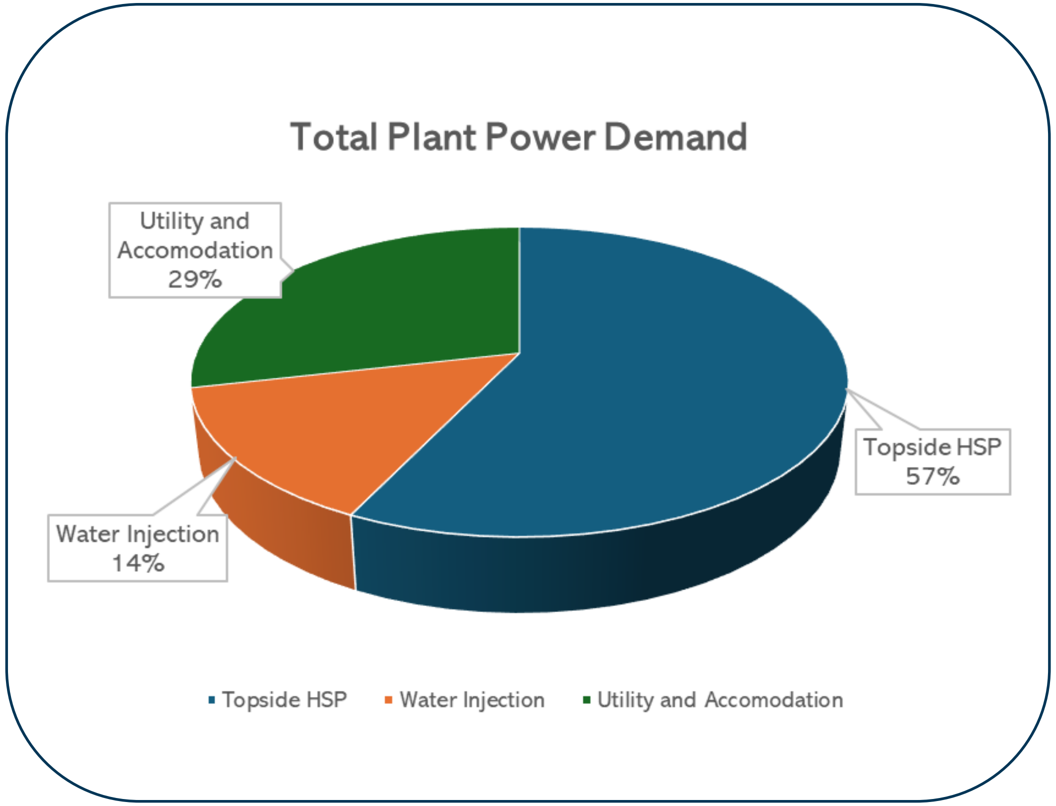
# ~~Problem~~ Opportunity Identification

As Kraken is a heavy oil field with low GOR, fuel gas volumes are insufficient for power, hence, requiring diesel-powered generators for these pumps, which significantly drives up carbon emissions.

The topside pumps collectively utilise a total power load of 20MW (enough to power over 40,000 UK homes). They require significant power as they operate at high speeds to generate required flowrates and discharge pressures.

They are the largest power consumers by a significant margin, utilising a combined 71% of total power demand.

We identified that any optimisation efforts towards pump operations can produce tangible power savings which will in turn offset diesel costs and carbon emissions.



# Oil Production as a Constant, not Objective

*Objective Function* *Constant* *Changing Variable*

*Flow Rate*

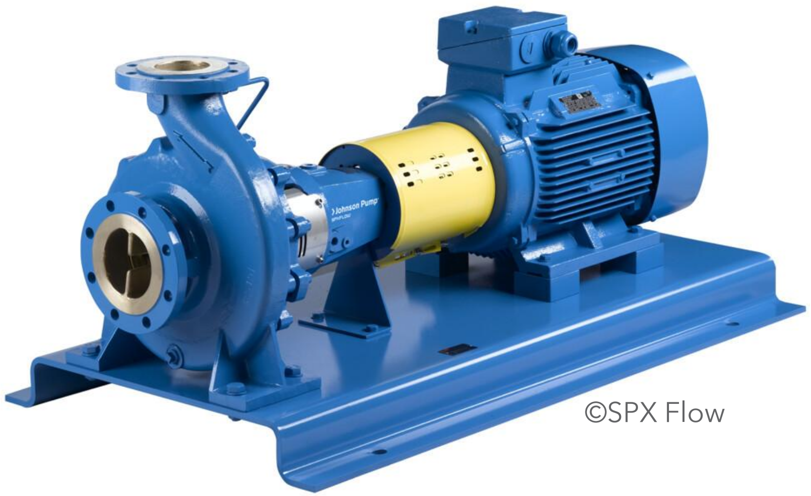
$$\text{Minimise} \downarrow \underbrace{P}_{\text{Pump Power}} = Q \,.\, \underbrace{\Delta P}_{\text{Head}} \downarrow \text{Minimise}$$

## Assumptions

Oil production already optimised.

## Constraints on variable $\Delta P$

- High pressure requirement of turbines in HSPs.
- High system water rates required (for power water and injection water).
- Maximum well injection rate limit in shared injection system.



# Pump-Optimisation Workflow

**1 Assess entire production system and determine points of system resistance (pressure losses).**

- Primary points: choke valves on the producers and injectors.
- Secondary points: Flowlines from the manifold to FPSO.

**2 Build integrated production model or simple surface flowline model. Match rates and pressure drops across the system.**

- Integrated production models were used to match HSP and WIP flowlines rates and pressures.

**3 Simulate the elimination of pressure losses in the system and determine optimum pump discharge pressure required to produce the desired rates.**

- Choke opening and use of drag reducers was modelled.
- For WIPs, optimum pressure to deliver the highest injection rate well at 100% choke was also checked.

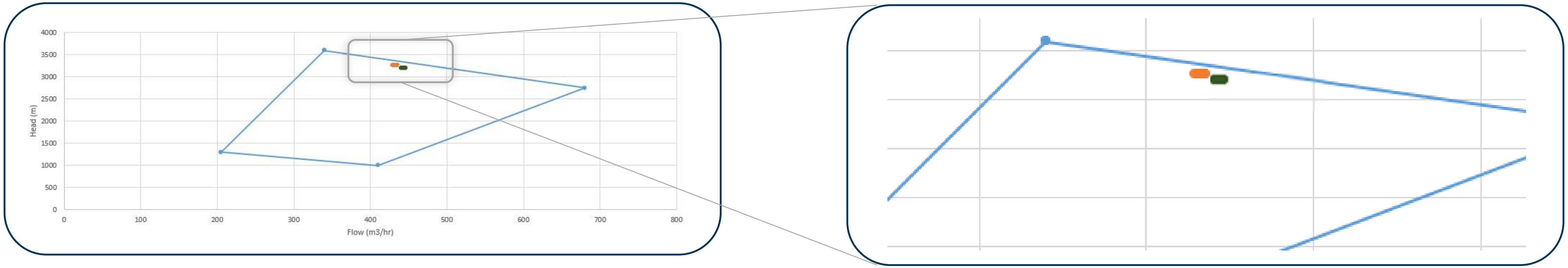
**4 If simulated pressure head and rates fall within pump operating region, eliminate pressure losses and implement new discharge pressure on the pumps.**

- In this case, choke opening for all producers and injectors while honouring well constraints.
- Subsequent drop in pump speed and power demand.

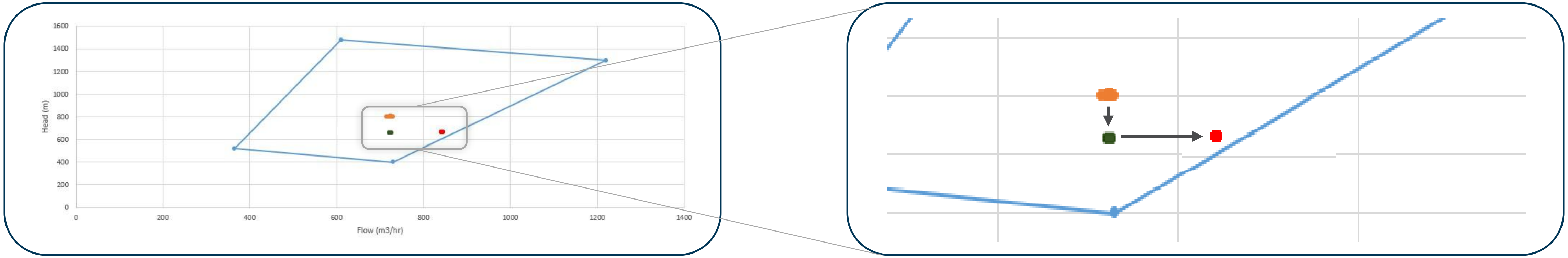
# Pump Operating Window – Operating Point Evolution

- Pre-optimisation
- Post-optimisation
- Current operation

## Power Water Pumps (Discharge Pressure reduced by 7 bar)




## Water Injection Pumps (Discharge Pressure reduced by 16 bar)



# Results Summary

- We achieved a 2% drop in power demand on the topside power water pumps and a 16% drop in power demand in the Water Injection Pumps post-optimisation. **No capital investment was required.**

**+0.9 MW**
TOTAL POWER DEMAND SAVINGS

Total savings in power demand after the execution of this strategy

Cost savings in diesel and emission costs per year.

**+£1MM**
TOTAL COST SAVINGS

**~70 Days**
EQUIVALENT FLARING EMISSIONS SAVINGS

Emissions savings per year equivalent to 70 days of zero routine gas flaring

Total savings per year (equivalent to planting 220,000 mature trees per year)

**+5kT$CO_2$e**
TOTAL $CO_2$ EMISSIONS SAVINGS

# Thank you/ Acknowledgement

enQuest

WALDORF PRODUCTION

*Partner*

BUMIARMADA

*Duty Holder*