Magnus Field Rejuvenation

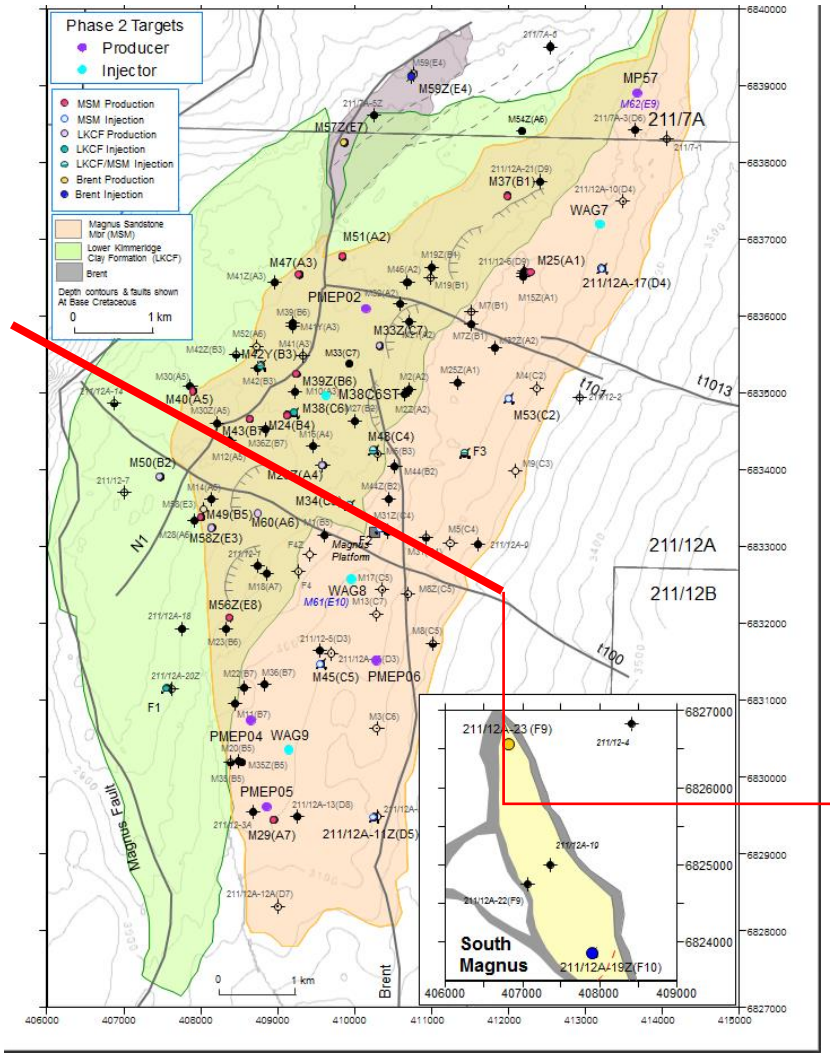
Ogaga Esharefasa
Petroleum Engineer

May 2017

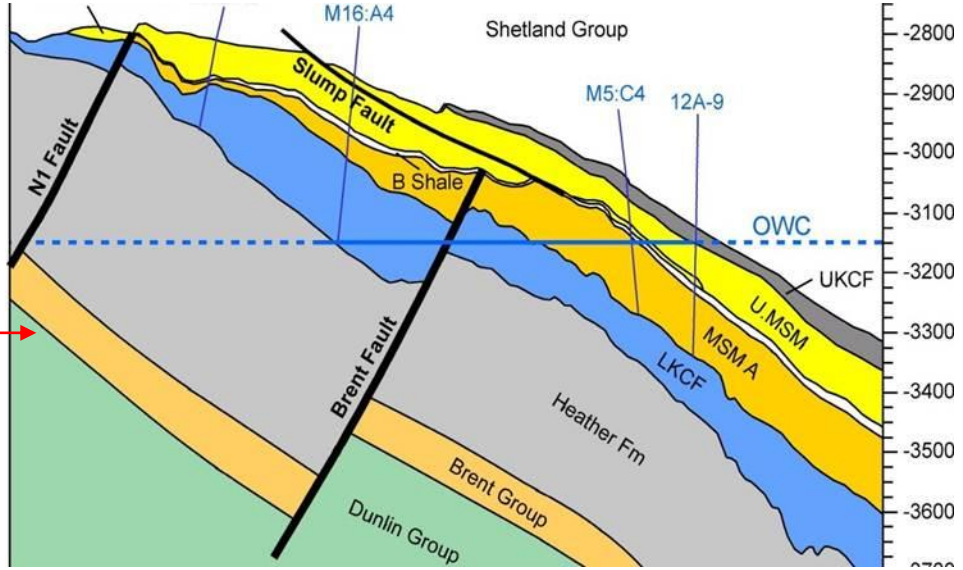
Outline

- Magnus history summary
- Magnus late life challenges
- Production efficiency challenges
- Rejuvenation strategy
- Late life production optimisation – WAG
- Results
- Success drivers
- Conclusions
- Questions

Magnus history summary

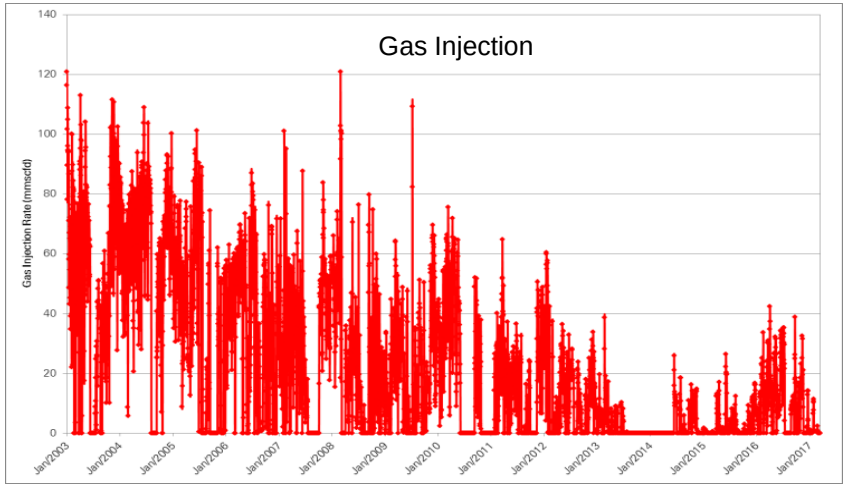


- Discovered in 1974, first oil in 1983
- Platform is 35yrs Old
- 2.0 bn boe HCIIP
- >100 well penetrations over 30+ years
- Complex reservoir structure
- Late life: WAG EOR commenced 2003

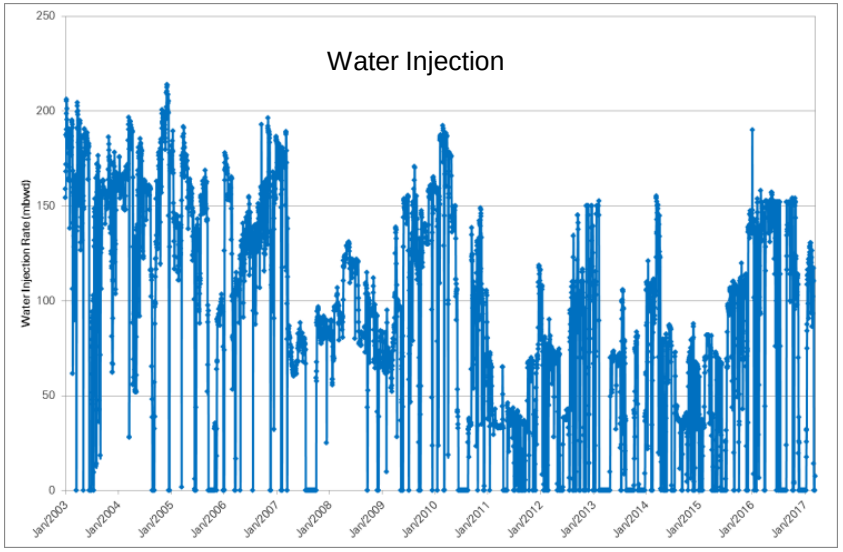


Magnus late life challenges

- Reservoir in Late Life
  - Overall field water-cut > 85%
  - Complex reservoir fluid distribution
    - Potential for by-passed oil
    - Infill drilling options
    - High impact of lack of water/gas injection
  - Challenges with gas supply for injection



- Reliability of old kit
  - Water injection pumps
  - Gas compressors
  - Fire pumps
  - Test separator
  - Age of trees – (frequent valve failures)
  - High 'critical jobs' volume
  - POB restrictions

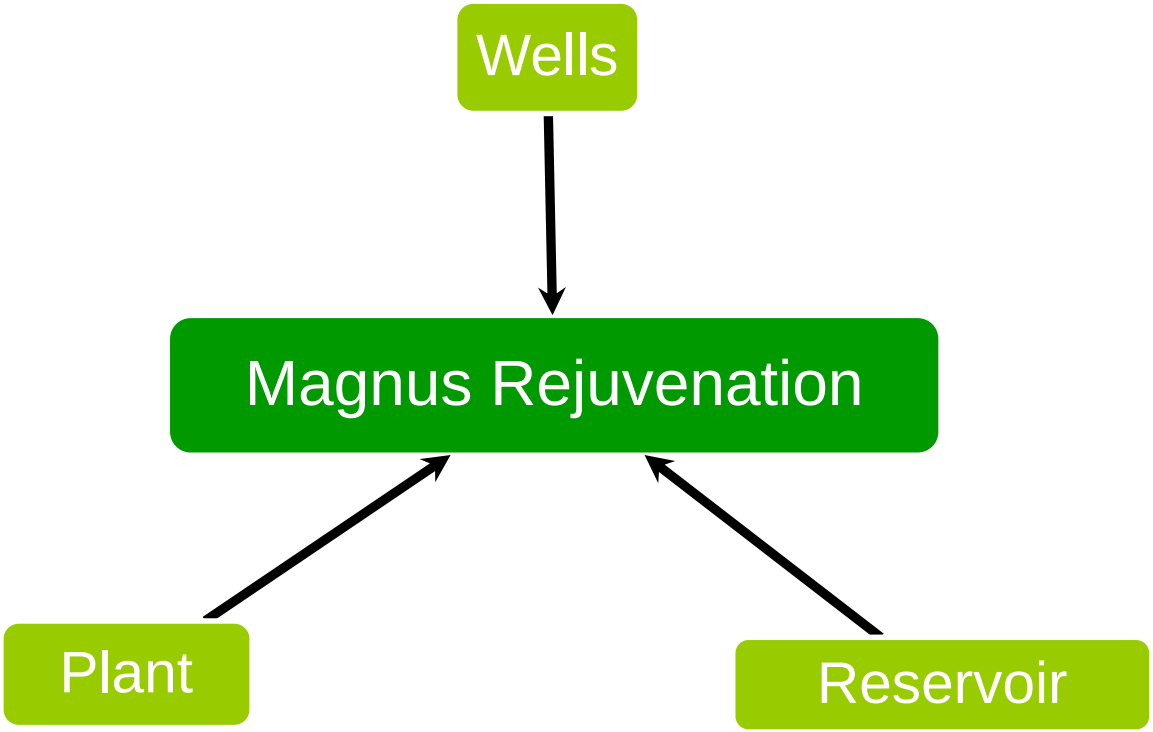


Magnus late life challenges

- Production Efficiency Challenges
  - Lack of Well Tests – Production optimisation
  - Deviation from reservoir management strategy
    - Gas and Water Injection targets not met
    - Gas Export due to failed gas injection compressor
  - Clashes in team priorities
    - Number of 'Important' activities going on offshore

- Reservoir Challenges
  - Sticking to the reservoir depletion strategy
    - Multifunction required to implement depletion strategy

Rejuvenation strategy

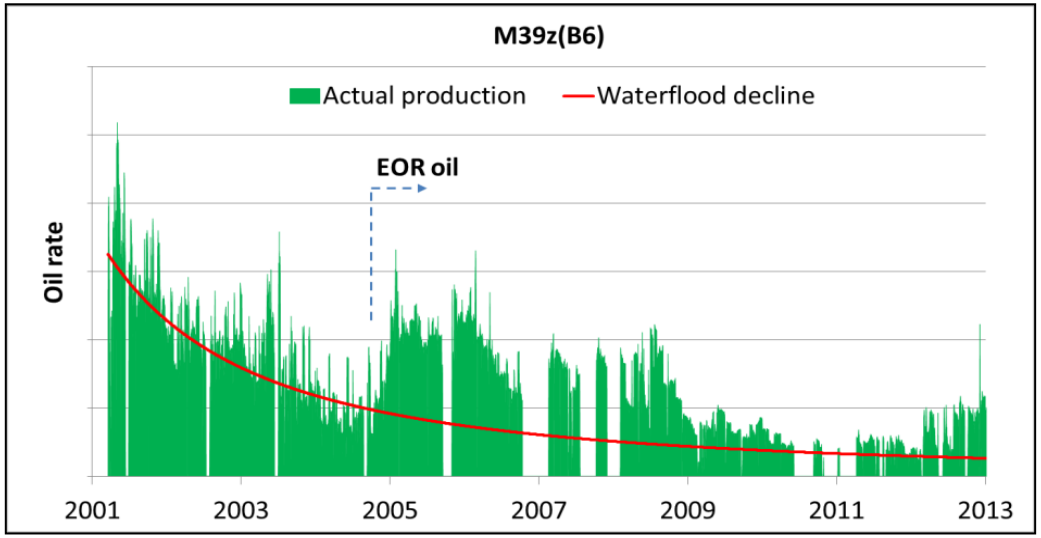


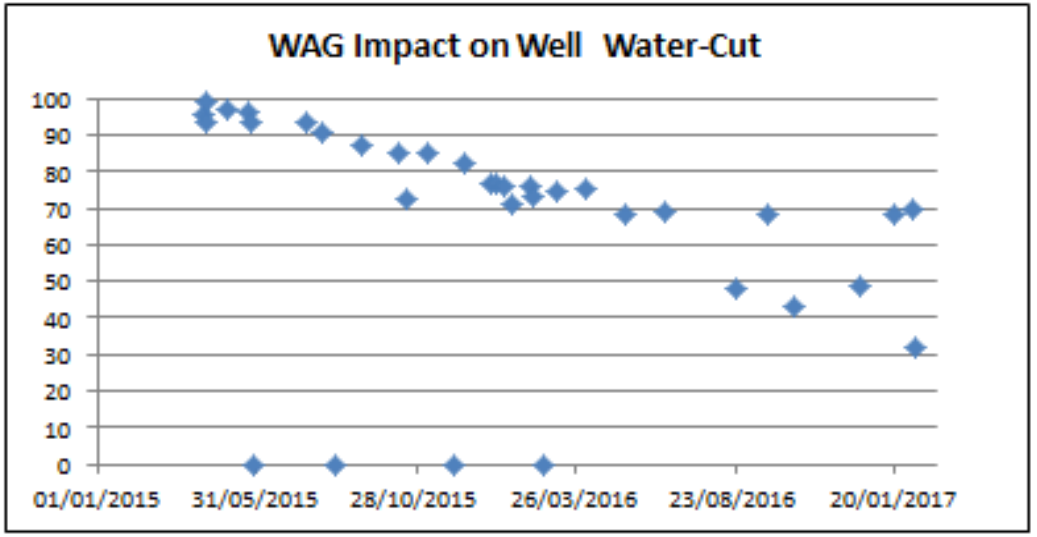
Wells rejuvenation

- Well Review
  - Identify common cause of production deferrals
  - Establish new culture to tackle problems (e.g. commit to obsolete tree changes)
  - Identify easy production enhancing opportunities and execute quickly
  - Identify longer term opportunities
  - Establish consistency and share learnings across offshore shifts for plant optimisation

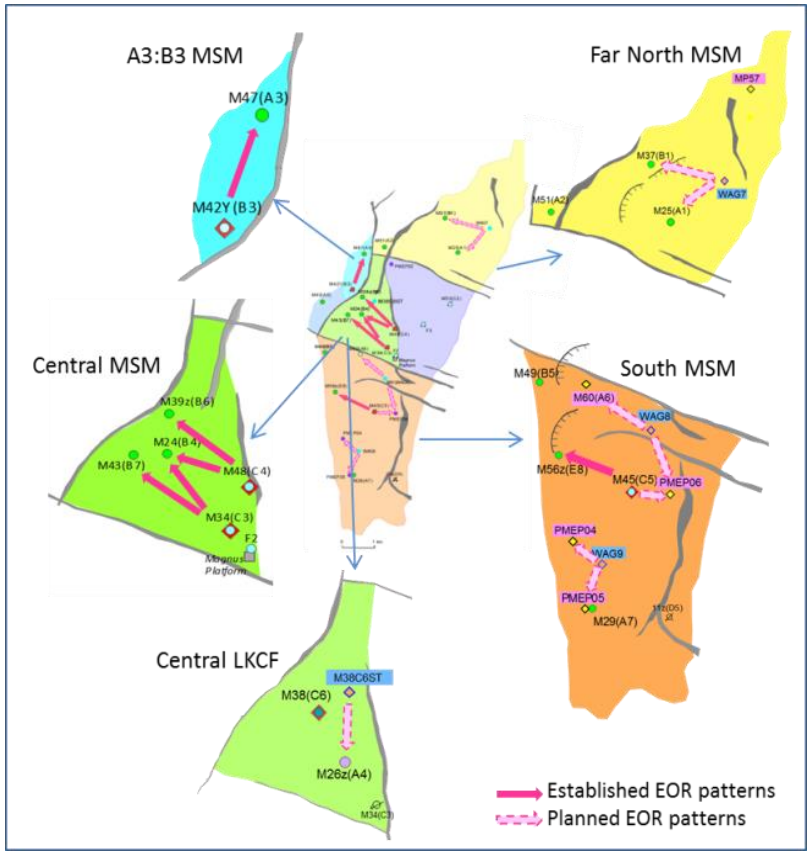
Late life production optimisation
WAG (EOR)

- WAG – Water – Alternating – Gas injection
- Started in 2003
- WAG EOR targets:
  - By-passed oil under shales
  - S_{or} reduction through miscible flood (from 25% to 8%)
- Residual oil saturation after miscible flood S_{orm}= 8% (corefloods)
- In recent years approximately 35% of Magnus production has been from WAG EOR – this will increase as the asset gets older





Reservoir rejuvenation



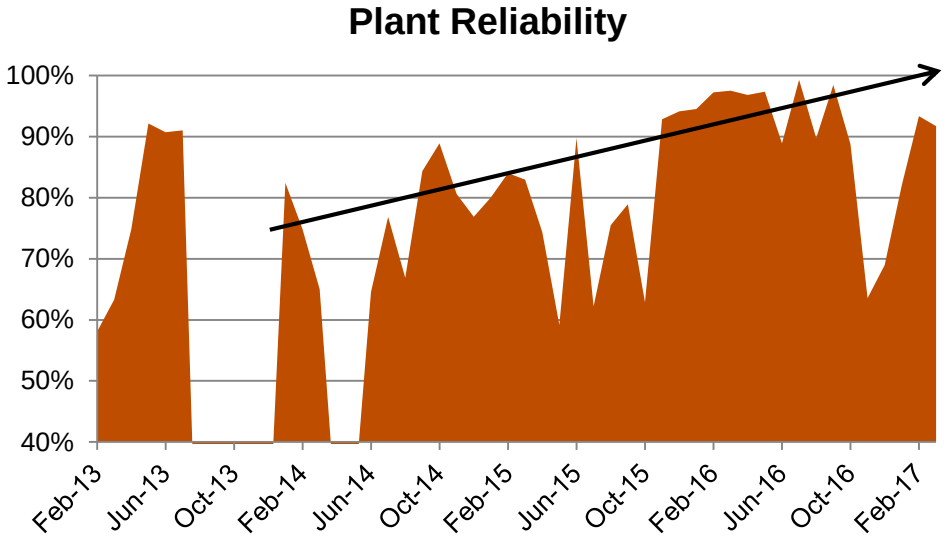
- Review Reservoir depletion strategy to ensure old strategies are still applicable and practicable
- Communicate short and long term strategies with Offshore/Onshore operations personnel
- Where possible, give the Ops team sufficient time to carry out requests

		*	2016								2017								2018								2019+
			Q1		Q2		Q3		Q4		Q1		Q2		Q3		Q4		Q1		Q2		Q3		Q4		
Central Panel	C3		G	30	W	30	W	20	G	20	G	20	W	20	W	20	G	20	G	20	W	10	W	10	G	10	W
	C4		G		G		G		W		W		G		G		W		W		G		G		W	
South Panel	C5		W		W		G		G		W		W		G		G		W		W		G		G	
	E10		W	N/A	W	N/A	W	30	W	30	G	30	G	30	W	30	W	30	G	30	G	40	W	60	W	60	WAG
	WAG9		N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A		W		G		G		
Total GI				30		30		50		50		50		50		50		50		50		50		70		70	All available gas

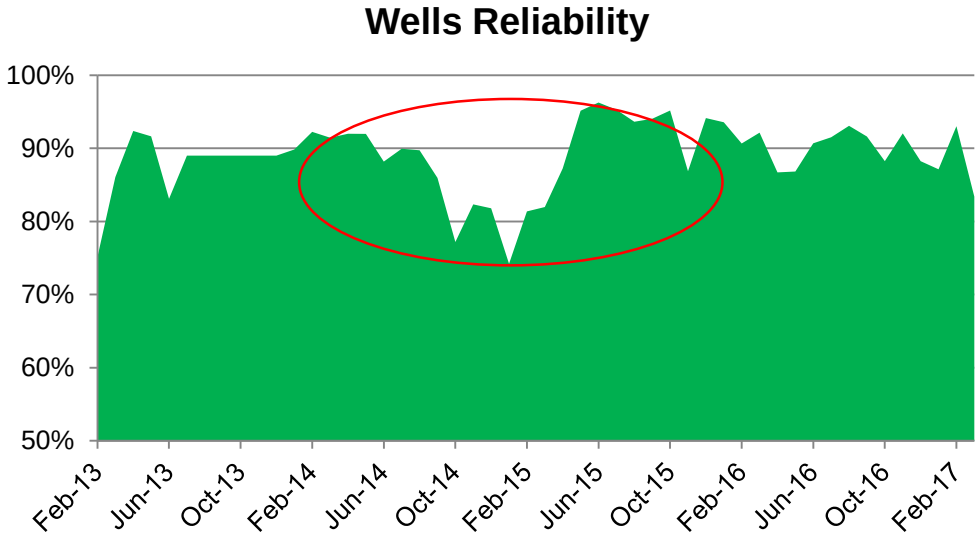
Plant Rejuvenation

- Ranking of vulnerability in terms of *Safety and Production* impact in the event of failure
- Job execution according to 'field wide strategy' rather than plant strategy
- Communicate strategy to relevant functions
  - Lunch and learn sessions
  - Frequent offshore visits by job owners

Results

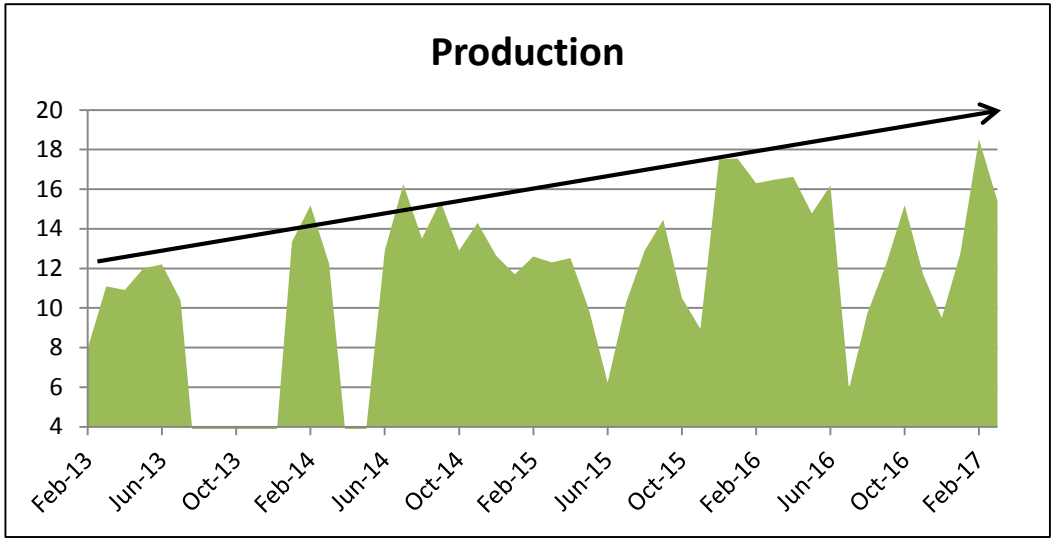


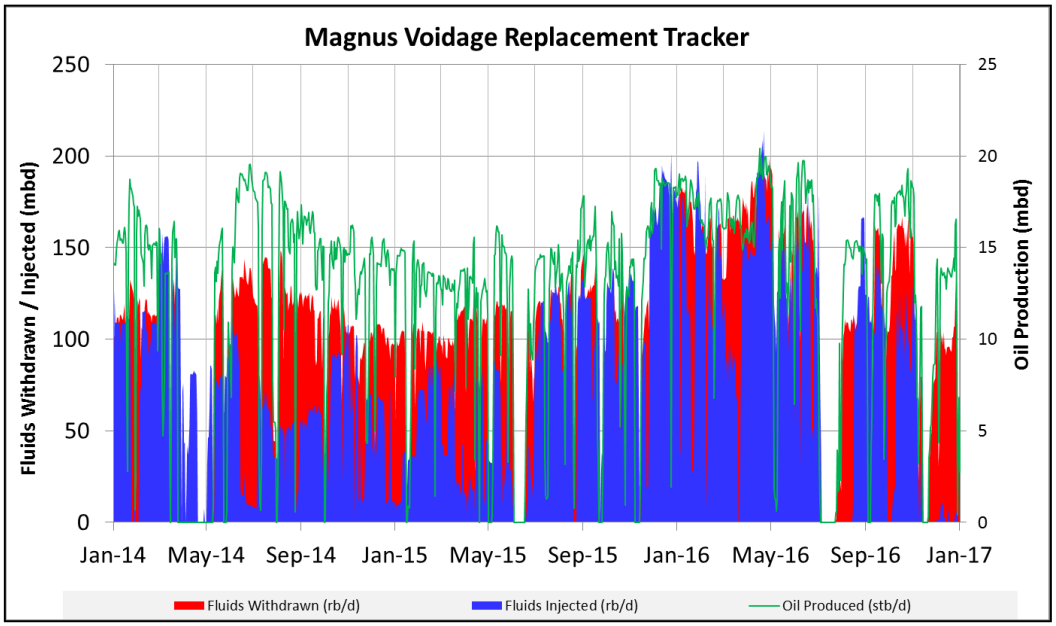
- Plant
  - Production increasing
  - Plant Reliability
    - 2nd Production Train reinstated
    - Fire pumps reliability restored



- Wells
  - >90% of wells now online
  - Well work planning now faster
  - Easy production wins actively chased

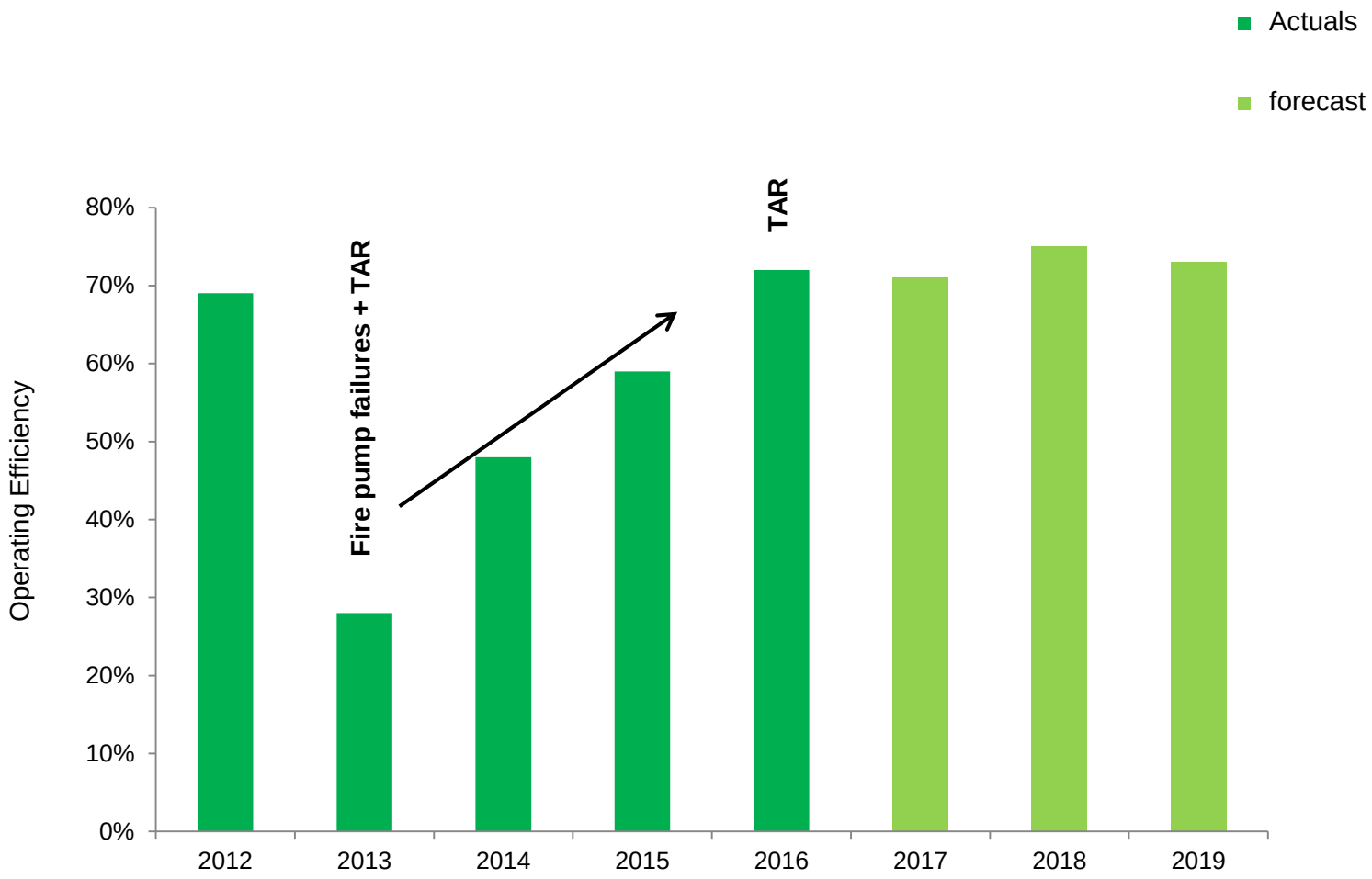
Results





- Production
  - Rare plant trips
  - Quick recovery in the event of trips
  - Plant redundancy restoration on track
  - More wells available for optimisation
- Reservoir
  - Now achieving target Voidage Replacement Ratios
  - Reservoir depletion strategy on track

Results – Operating Efficiency



Success drivers

- Alignment of Priorities between functional teams
- Clear communication between leadership of functional teams
- Leadership commitment to ‘One Team’ approach
- Teams understand the strategy of other teams
- POB reduction

Conclusions

- Align priorities between teams
- Sub-teams are surprisingly unaware of each other's priorities/strategy
- Steer away from 'the loudest voice in the room' culture
- Restoring efficiency to either plant or wells or reservoir is not sufficient.
- The entire system of plant/wells/reservoir are equally important. Maintenance must be progressed in a holistic manner.

Questions?