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Low Cost, High Profit Rejuvenation of Mature Fields

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Society of Petroleum Engineers
Distinguished Lecturer Program
www.spe.org/dl

Buenos Aires
Argentina

Key Takeaways

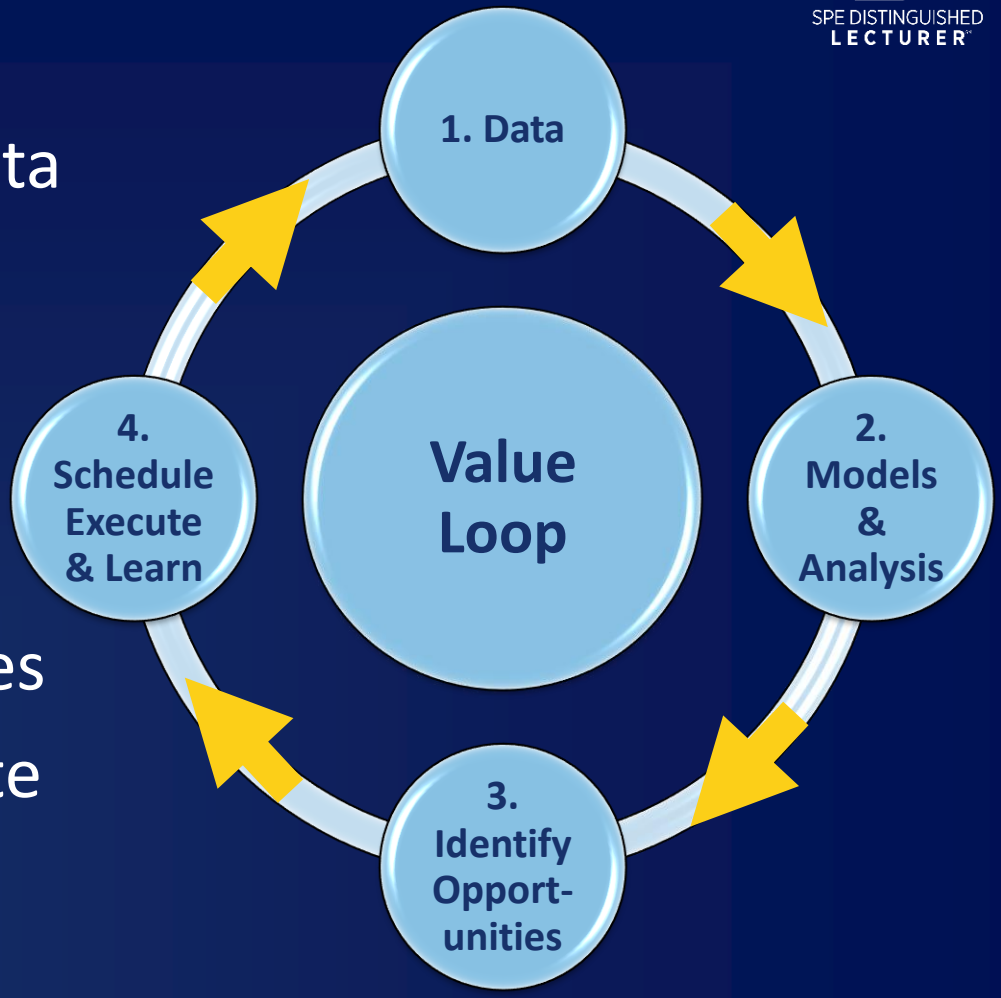
- Power of Tools and Processes
- Integrated Teams
- Data Analytics
- “Produce the Limit” Workshops

Objectives

- Rejuvenation of mature fields:
  - Practical strategies
  - Processes
  - Applications
  - Examples of case studies
- Reduce operational costs (10-20%)
- Maximize profit from existing wells and facilities (Return on Investment ca. 500%)

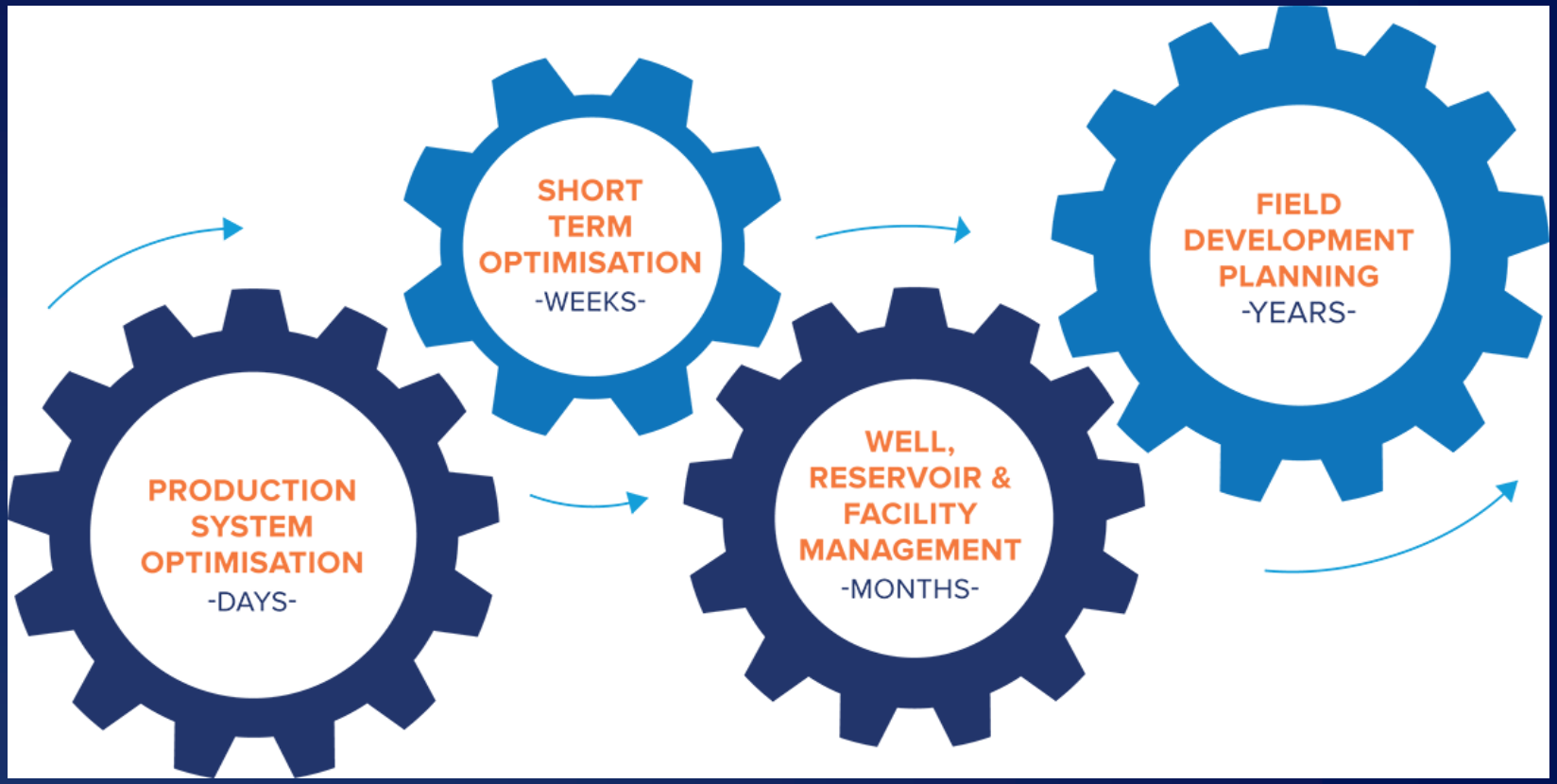
The Value Loop

- Gather and verify data
- Build and calibrate models
- Assess field performance
- Identify opportunities
- Schedule and execute
- Learn and share



Aim : maximise production and recovery

Value Loop Timescales



The Big Questions

- Why is production declining?
- Why are costs high?
- Why are wells shut in?
- Why is the field operated in this way?
- Why can’t we change things?

Produce the Limit

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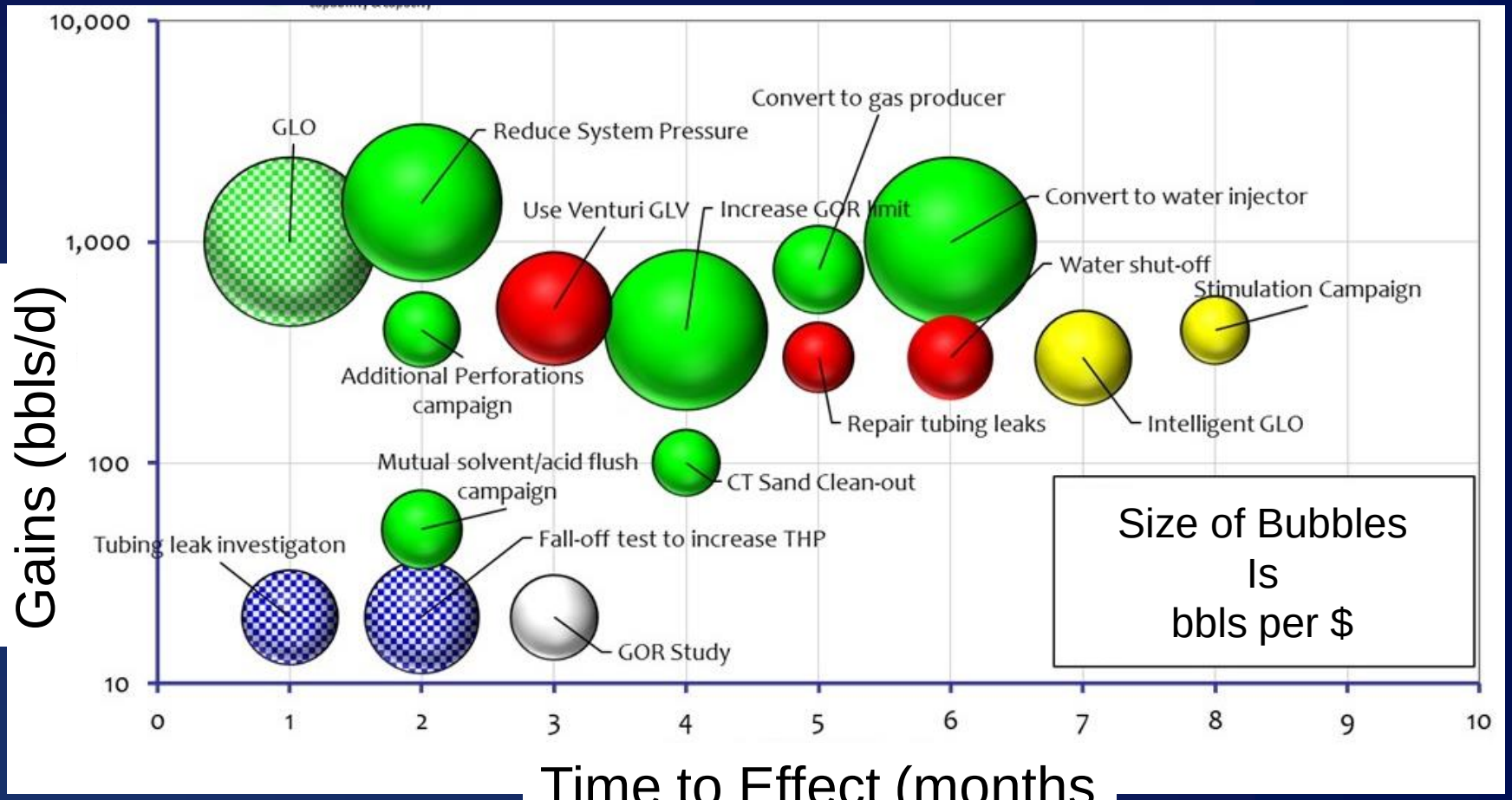
1. Get team together • Get management steer • Define objectives		2. Paint the picture • Share and explain data • Identify opportunities • Identify bottlenecks in system	
3. Evaluation • Generate the Opportunity Bubble Plot • Rank and prioritise opportunities – look for low hanging fruit (fast, easy and low cost)		4. Looking forward • Make plan to implement opportunities • Feedback to management and get commitment	

Opportunity Bubble Plot



Typical Gains and Time to Effect
(More opportunities are available)

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Opportunity Type	% Gain (% of oil rate)	Time to Effect (months)
Bean Up and Test Wells	5-10	1
Open Well and Test	0-30	2
Sand Issues (Run insert screens)	5-10	6
Gas Lift Optimisation	5-15	3
Zone Change	10-20	3
Additional or Re-Perforations	5-20	4
Stimulation	10-30	8
Water Shut-Off (>95% Water Cut)	10-50	8
Inject H_2S Scavenger	0-10	3
Coiled Tubing Clean-Outs	10-20	6
Sidetrack	500-1000 stb/d/well	12
Reservoir Saturation Tool	-	3
Production Logging Tool	-	3

What Kind of Reviews

Peer Review	Objective	Subsurface	Surface	Frequency
Opportunity Framing	Kick off a project and make a plan	✓	✓	anytime
Production Optimisation Review	Short-term optimisation of the wells and facilities	✓	✓	Daily, weekly, monthly
Well Review	Short-term optimisation of the wells	✓	×	Monthly, bi-yearly
Produce the Limit	Deep dive review from reservoir to export	✓	✓	6-24 months
Well and Pattern Reviews	Optimise recovery in each pattern	✓	×	Monthly, bi-yearly
Loss Management Review	Review deferment bad actors	✓	✓	Daily, weekly, monthly
Integrated Field Review	Full field review with new data (e.g. 4D Seismic)	✓	✓	6-24 months

Examples

- With these ideas, you can:
  - Review any field, reservoir, wells and/or facilities
  - At any time
  - With whatever data is available and
  - Whoever is available
- Keep asking Why, Why, Why?
- Be creative and constructive
- No right or wrong answers, just opportunities

Onshore Middle East
Major Producer

- Management concerned about rapidly declining production
- Multiple assets – different ways of working
- 1000's workovers – which to do?
- Massive upside – 100,000 bbls/day
- Data analytics:
  - Root cause
  - Quantify issues
  - Prioritise solutions

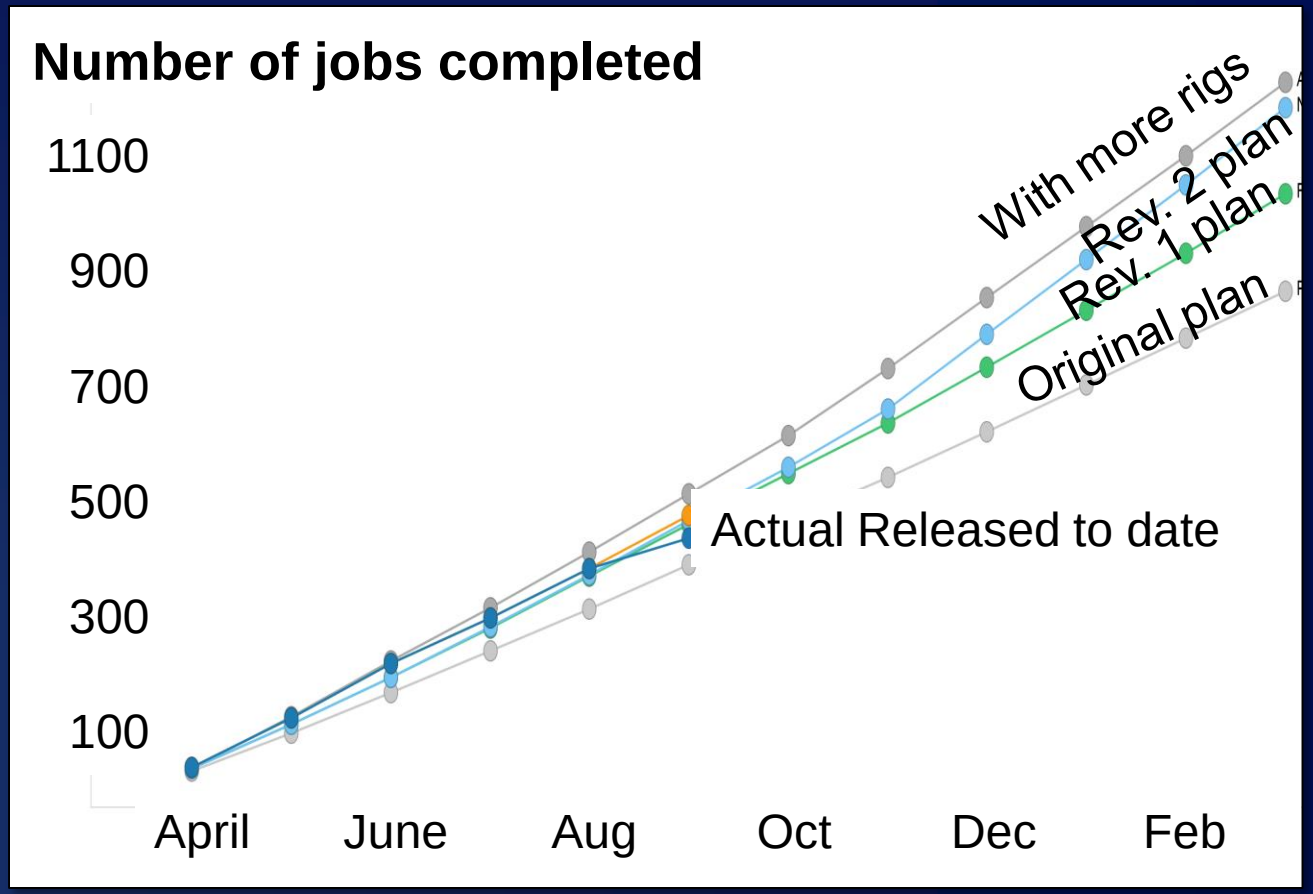
Data Analytics – Workover Schedule

Process

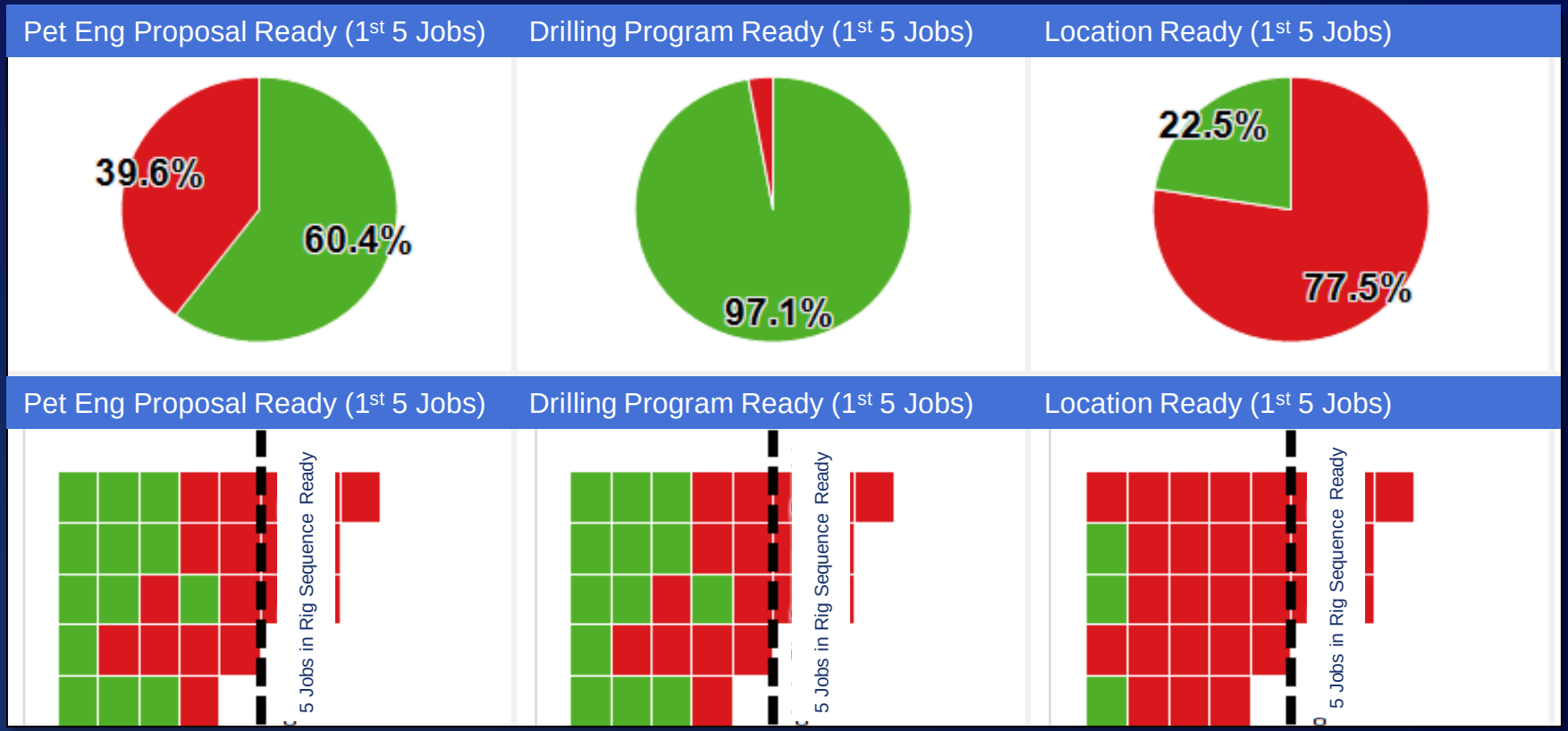
- Collect data & visualise
- Analyse & identify pain points, improvements
- Test conclusions
- Implement

Results

- Workover ranking – bbls/day per rig day
- Required more rigs
- Led to higher production (ca. 100,000 bopd after 12 months)



Data Analytics for Production Optimisation



Workover Job Readiness (Green = Ready, Red = Not Ready)

- Proactive checking to make sure jobs are ready (program, location, materials and artificial lift equipment)
- Why are things not ready?

Data Analytics – Connection Times

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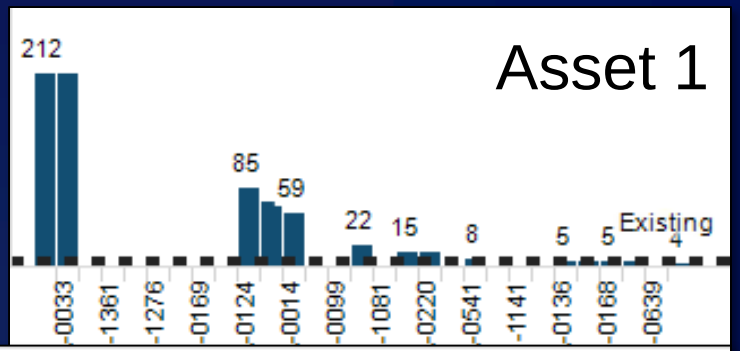
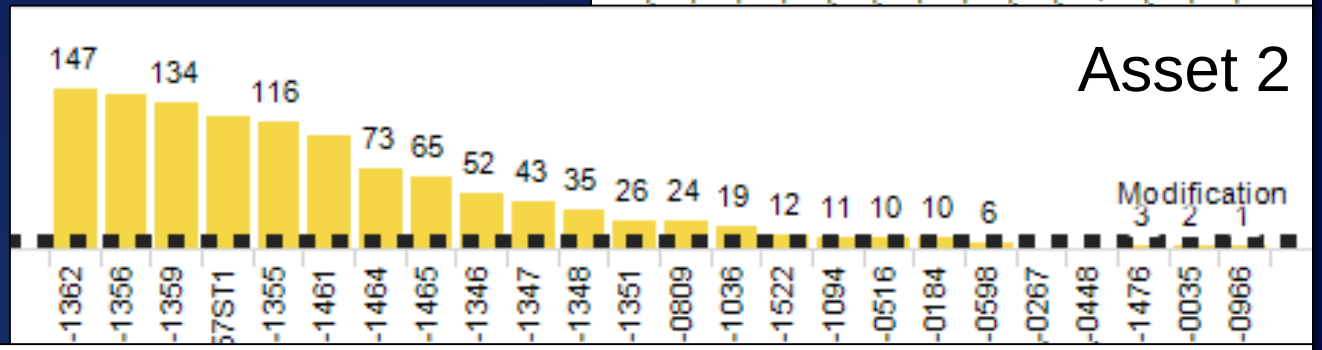
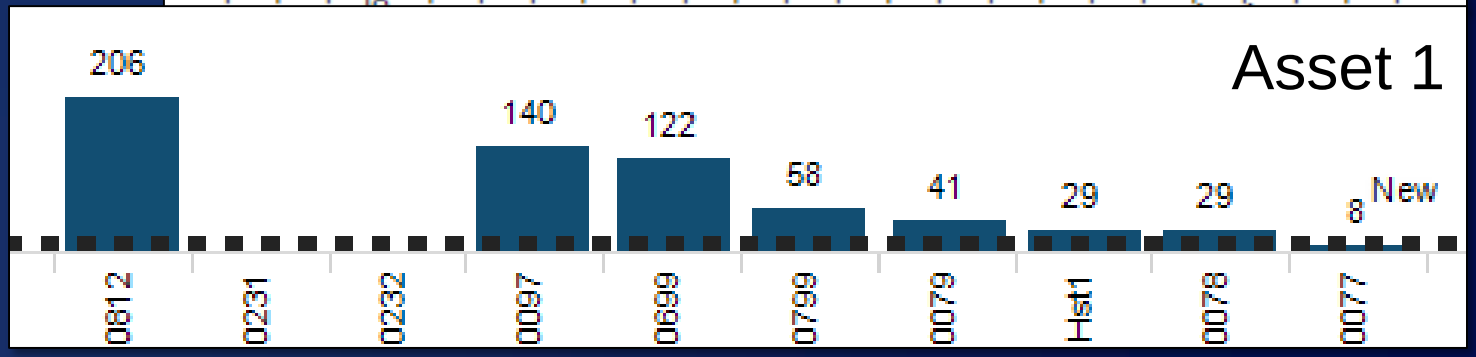
Connection Dashboard

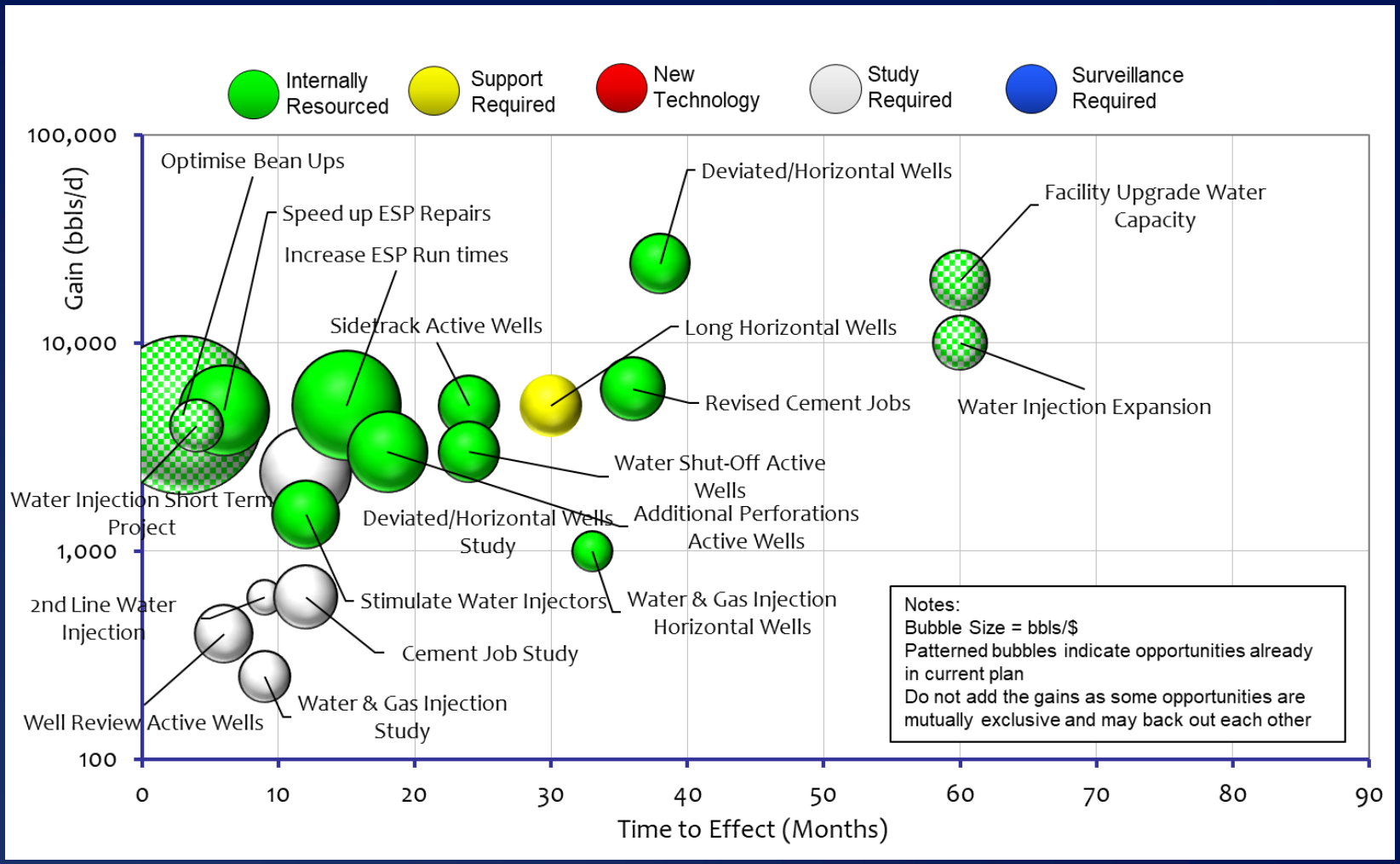
- How much production is waiting for connections?
- Target time to (re)connect wells – 14 days
- Delays due to materials, staff, access, permits
- 1 day delay is 700 bopd
- 10,000's bopd per year







Produce the Limit



Opportunities ca. 70,000 bopd over next five years

Cost Savings – Chemicals

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Scale and emulsion

- How:
  - Chemical injection at wellhead helps
  - High Chemical usage
  - Doesn't solve scale buildup in well
  - Integrated team develop solutions
  - Capillary tube in ESP cable
- Results
  - Reduced chemical costs (>$100,000/yr)
  - Reduced formation of scale and emulsions (100's bpd extra oil)
  - Reduced remedial costs of cleaning tubing and flowlines (ca. $1 mln/yr)

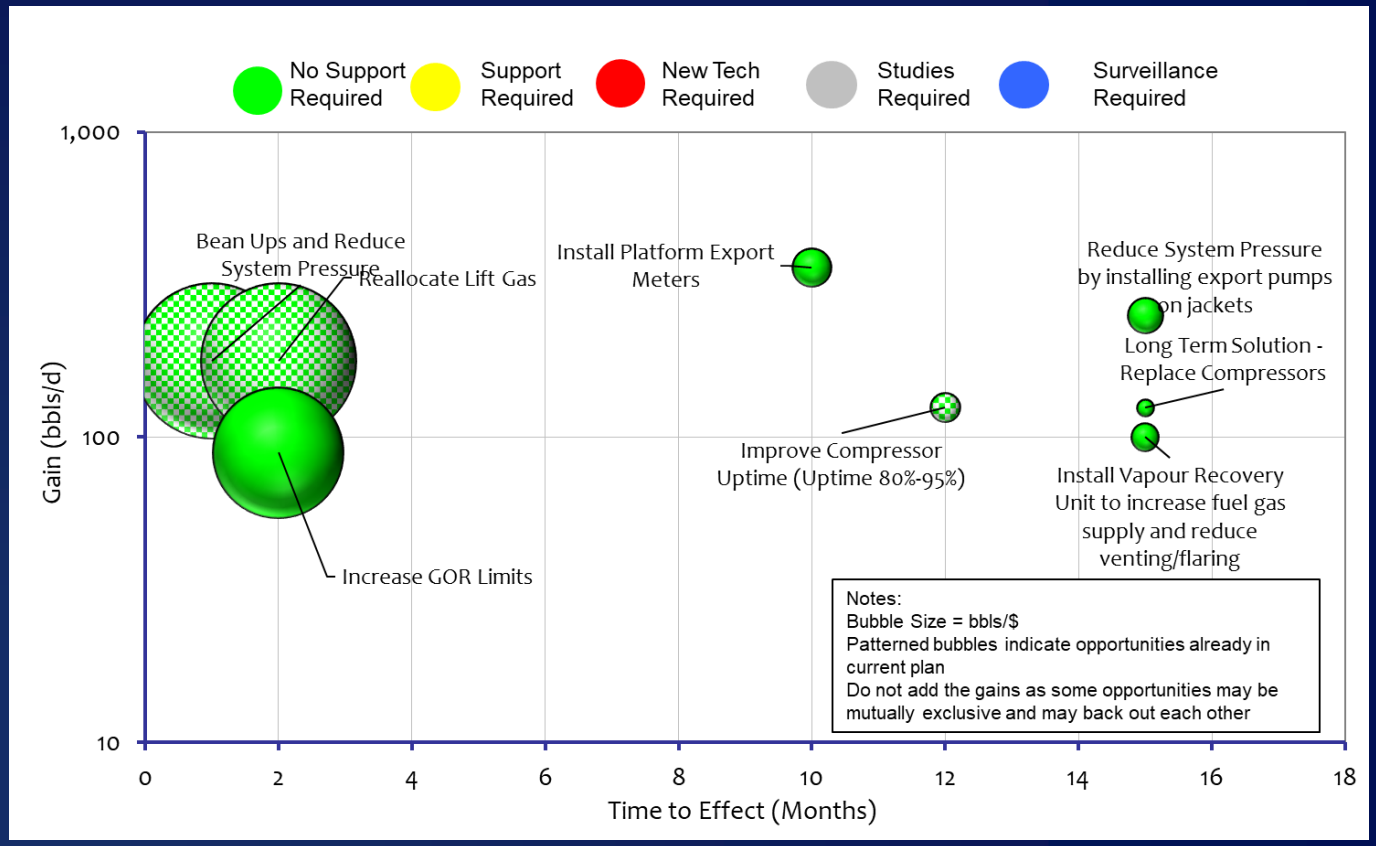
Courtesy of Schlumberger

Offshore, Asia-Pacific Independent Producer

- Four mature fields - low production (ca. 5,000 bopd)
- Wells were gas lifted – needed optimisation
- Offshore - low costs
- Models out of date
- Lack of coordinated effort

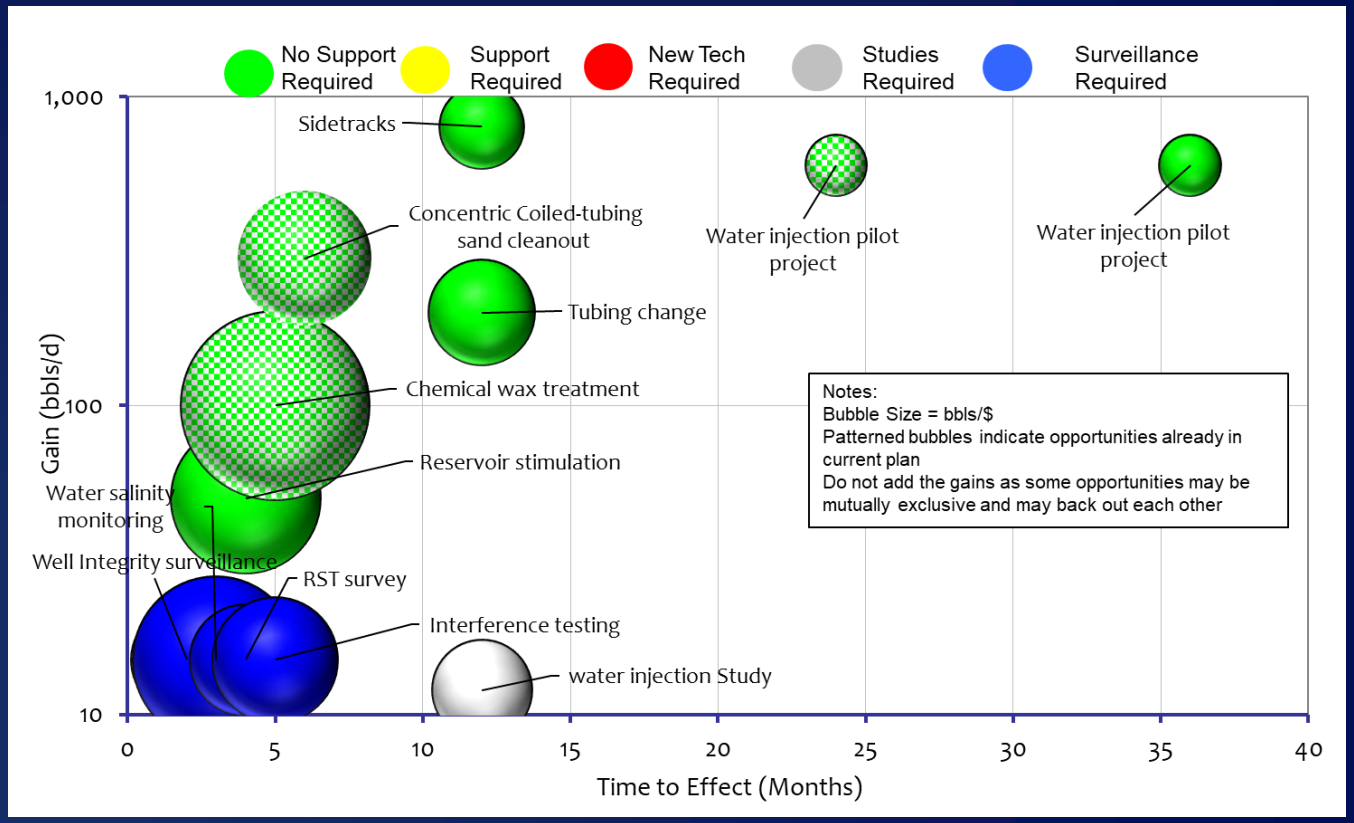
Gas Lift Optimisation

- Integrated Opportunity Bubble Plot
- Developed models
- Quantified gains
- Reality check - confirmed size of gains and doability
- Management close out
- Gains ca. 1,000 bopd – half within 2 months



Well Reviews

- Updated well books
- 2 locations in well reviews
- Surveillance plan made
- Reality check - confirmed size of gains and doability
- Gains ca. 2,000 bopd in 12 months



Onshore, North Africa
Major Producer

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- Cost of ESP failures
  - 50 active wells with ESPs, replaced every year - $25 mln/yr
  - If it takes 30 days between ESP failing and well back on production, then lost production is $75 mln/yr
  - Total cost of ESP failure in this field was $100 mln/yr
- Multiple causes of ESP failure
  - The team suspected that using old ESPs is probably the main problem
  - ESP failure statistics were required to quantify which elements cause the highest failures
  - Some ESPs run for several years – why?

Value of ESP Optimisation

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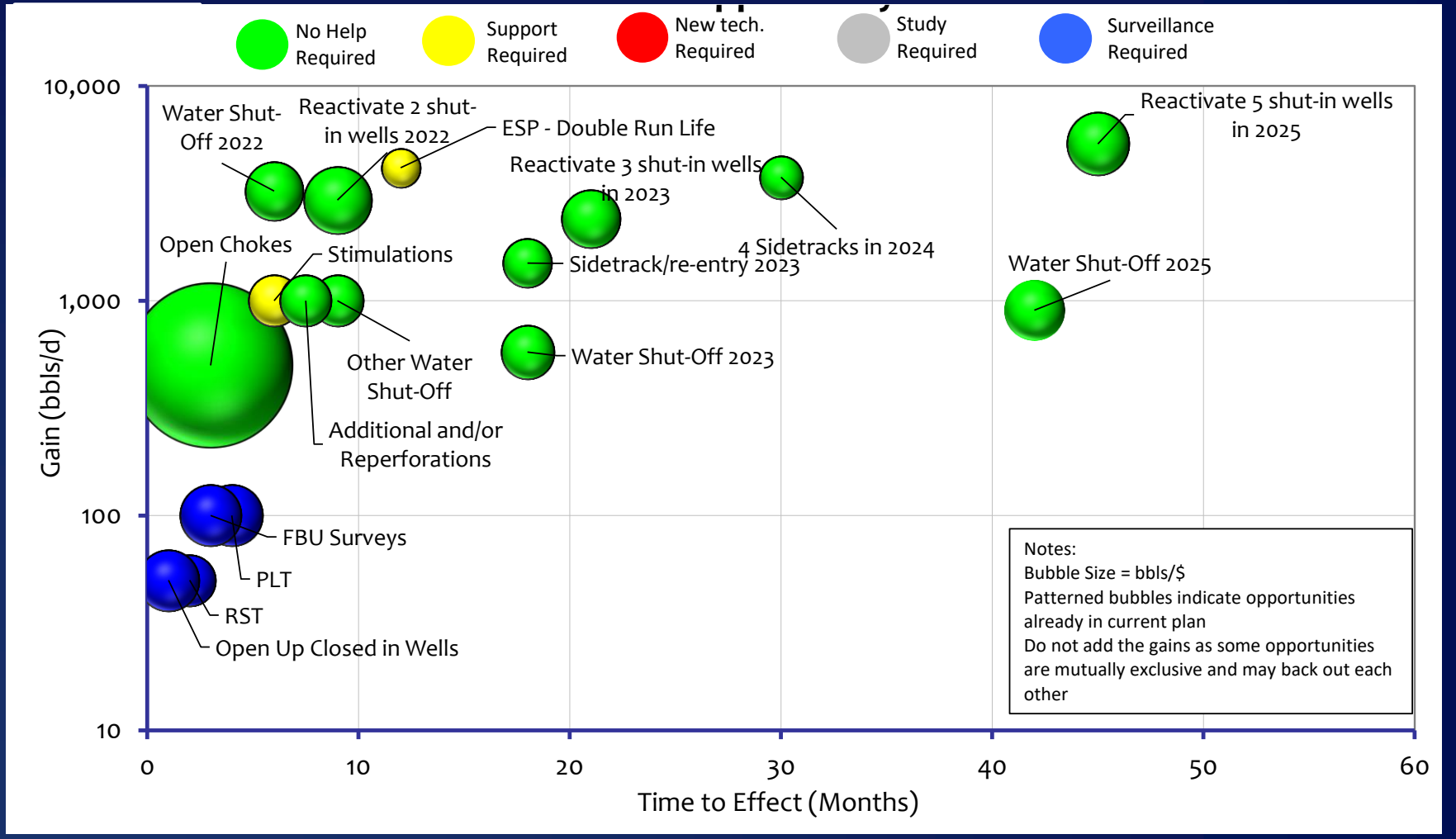
- Proposed solution
  - Form integrated team
  - Analyse ESP failures from the last 3 years - Root Cause Analysis
  - Offer solutions
  - Rank, prioritise solutions
  - Reduced costs of ESP failure
- Also carried out in-depth field review to rejuvenate field
  - Well and Reservoir Surveillance
  - Rigless activities
  - Workovers
  - Sidetracks
  - Infill wells
  - Opportunity Bubble Plot

Opportunity Bubble Plot



Opportunities ca. 30,000 bopd over next five years

Offshore Middle East – Independent Producer Well & Reservoir & Management

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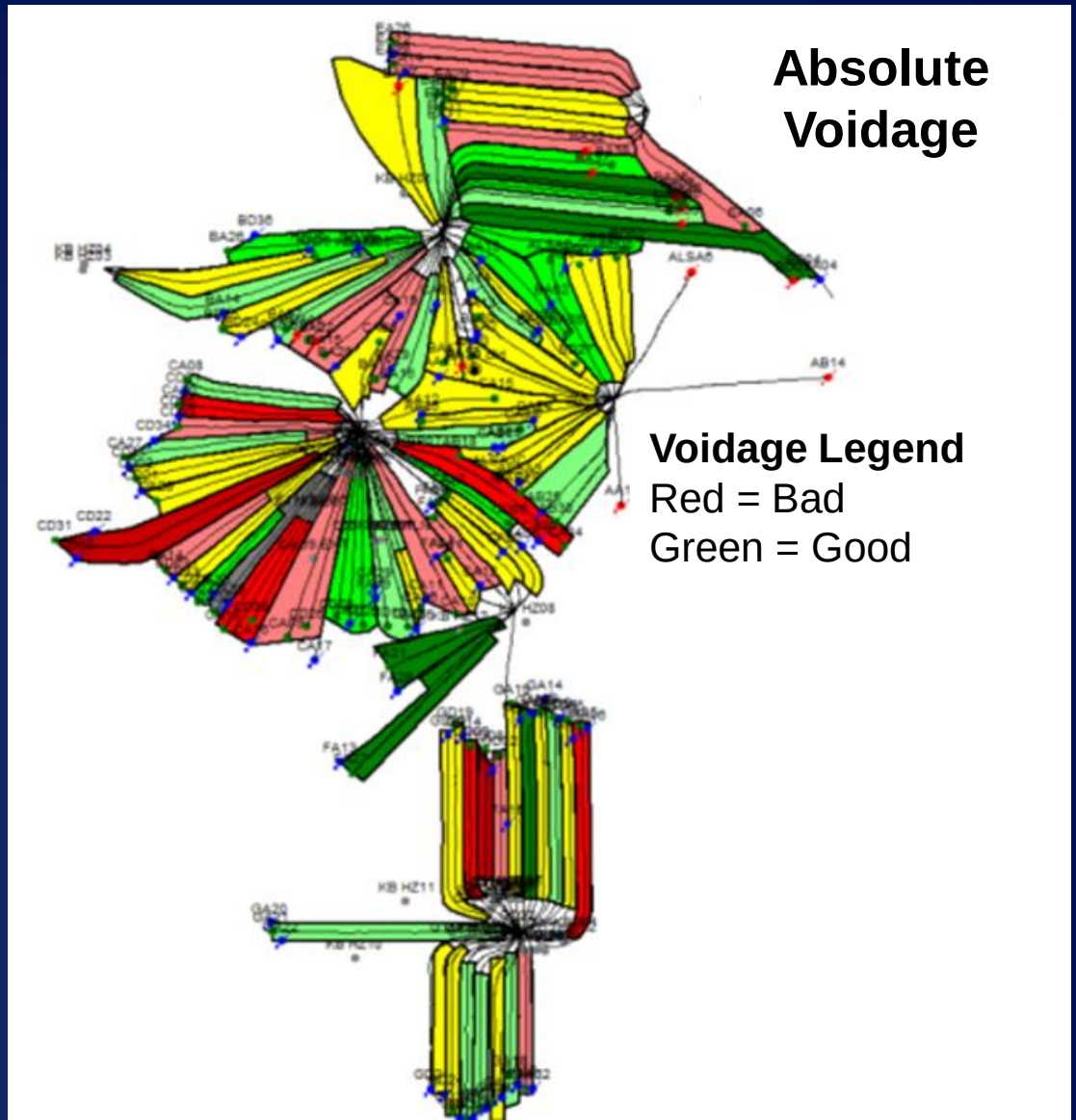
- Develop Reservoir Management Strategy & Plan
  - Voidage per pattern
  - Replacement Factor
  - Pressure Response
- Well & Reservoir Surveillance Plan
- Souring Studies
- Identify good and bad areas
- Optimise water placement and oil offtake
- 10 bbls of water gives 1-2 bbls in six months
- Gains ca 30,000 bopd



Conclusions

- Rejuvenation - hard work!
- Collect all data and knowledge
- Value Loop systematic and consistent
- Identify and prioritise opportunities
  - Creaming curve (barrels per dollar)
- Spend money, to make money
- There is always more to optimise

Peer Review	Objective	Frequency
Production Optimisation Review	Short-term optimisation of the wells and facilities	Daily, weekly, monthly
Well Review	Short-term optimisation of the wells	Monthly, bi-yearly
Produce the Limit	Deep dive review from reservoir to export	6-24 months
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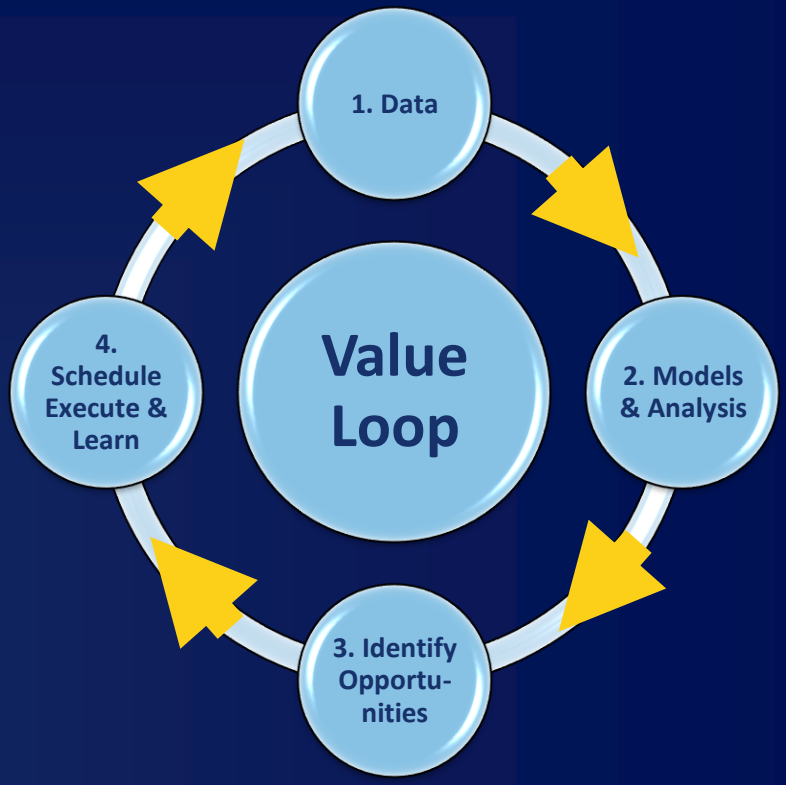
Back-Up

How does the Value Loop Work?

- People
- Data
  - Human and/or Artificial Intelligence (AI)
- Models
- Collaboration and teamwork
- Technology
  - What works
  - What doesn't work
  - What hasn't been tried



Aim : maximise production and recovery

The Power of Peer Reviews
(Especially Integrated Reviews)

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- Subsurface
- Facilities
- Integrated preferred
- Any time, any place – even virtual

People + Data/Information

=

Barrels and Dollars

Data Analytics for Production Optimisation, Onshore Middle East

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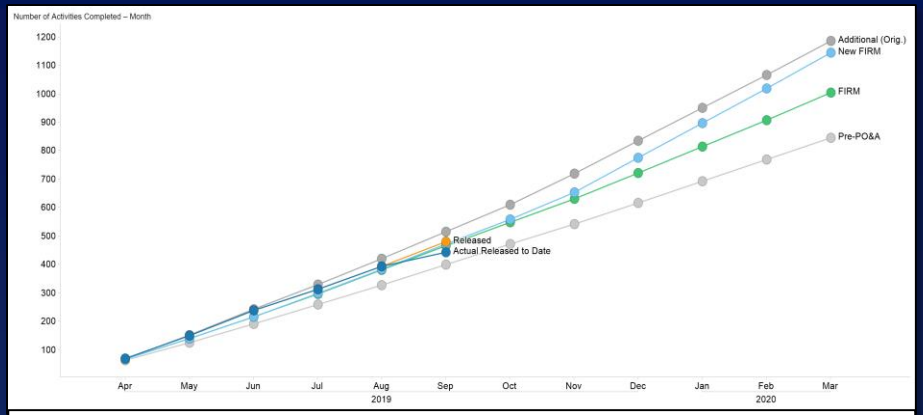
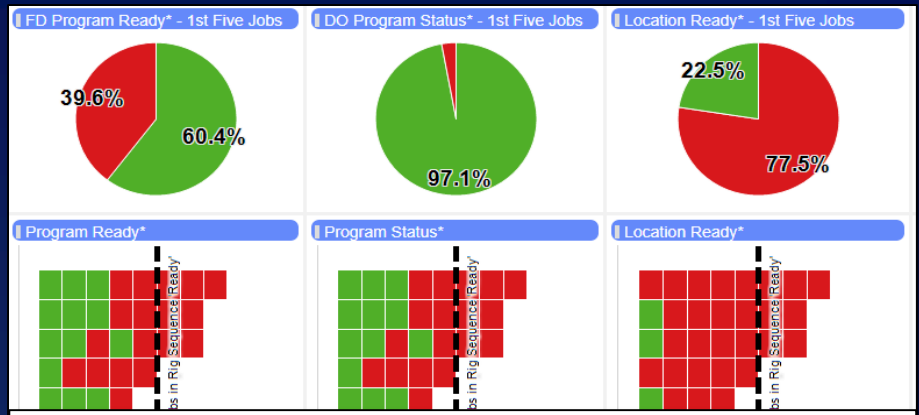


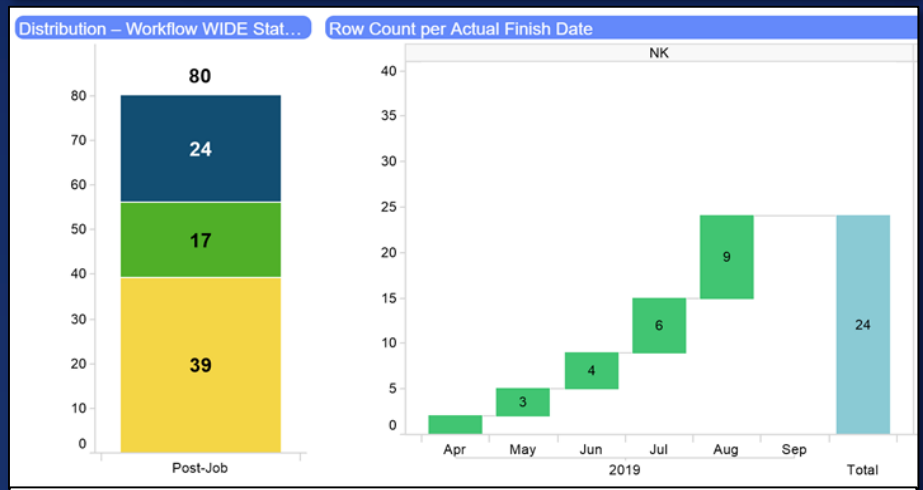
Workover Tracking

Tracking actual number of workovers and gains against the plan. Taking action when deviation occurs.



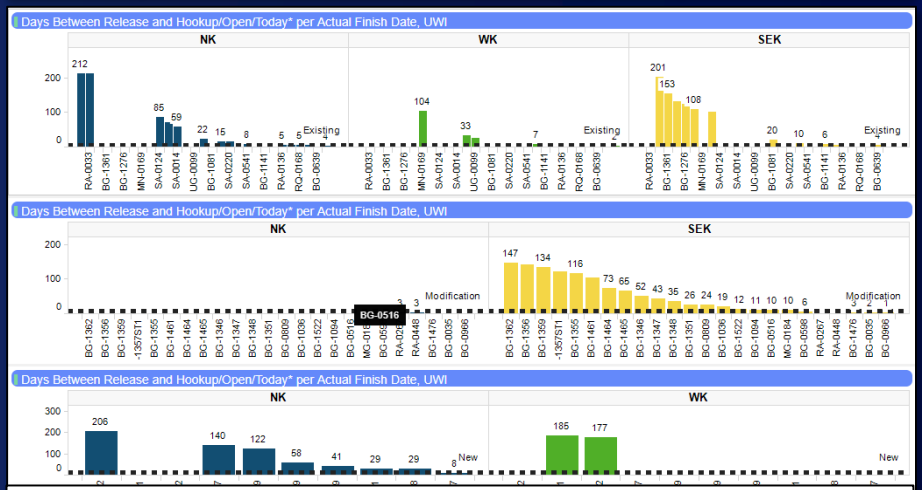
Workover Job Readiness

Proactive checking to make sure jobs are ready (program, location, materials and artificial lift equipment)



Overrun Analysis

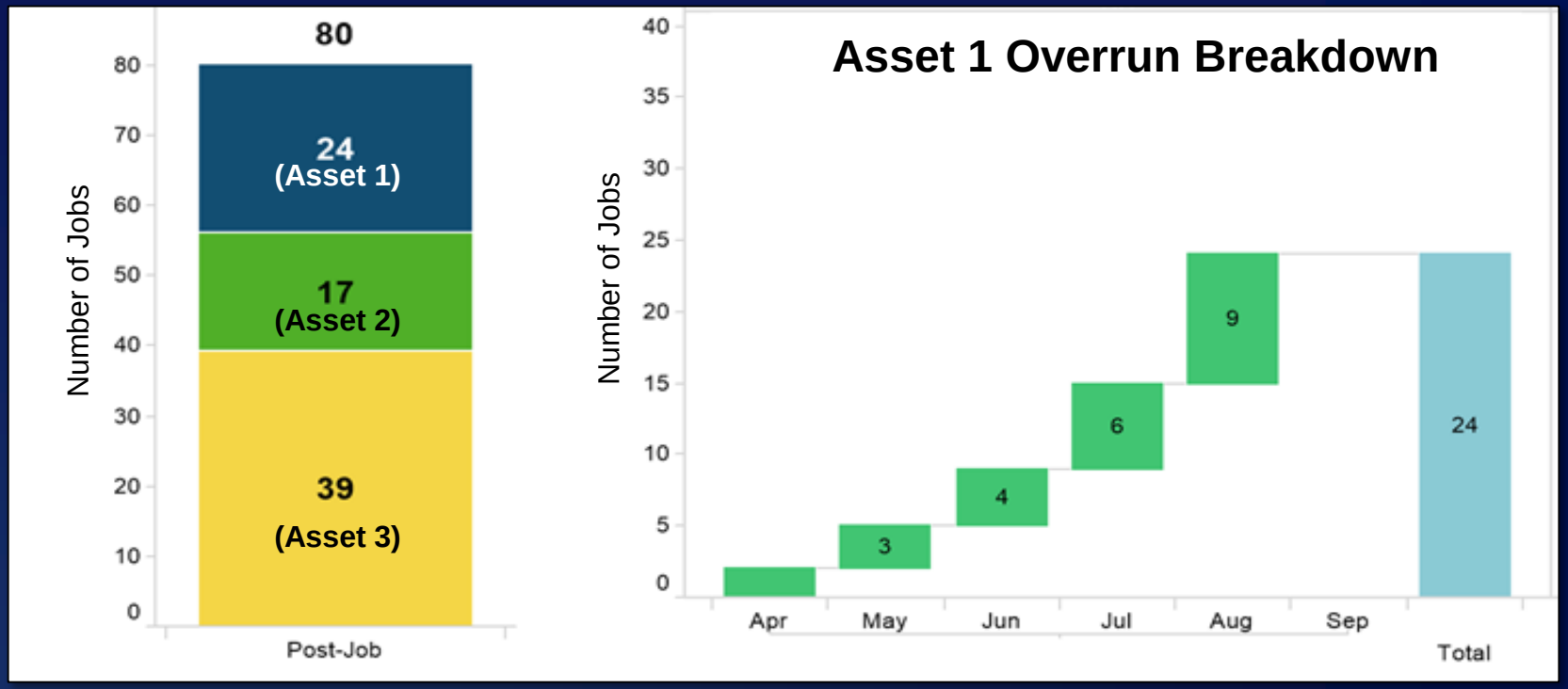
Reporting planned versus actual analysis (gains, durations, number of activities)



Connection Dashboard

How much production is waiting for connections (delays are investigated by core team)

Data Analytics – Job Overruns

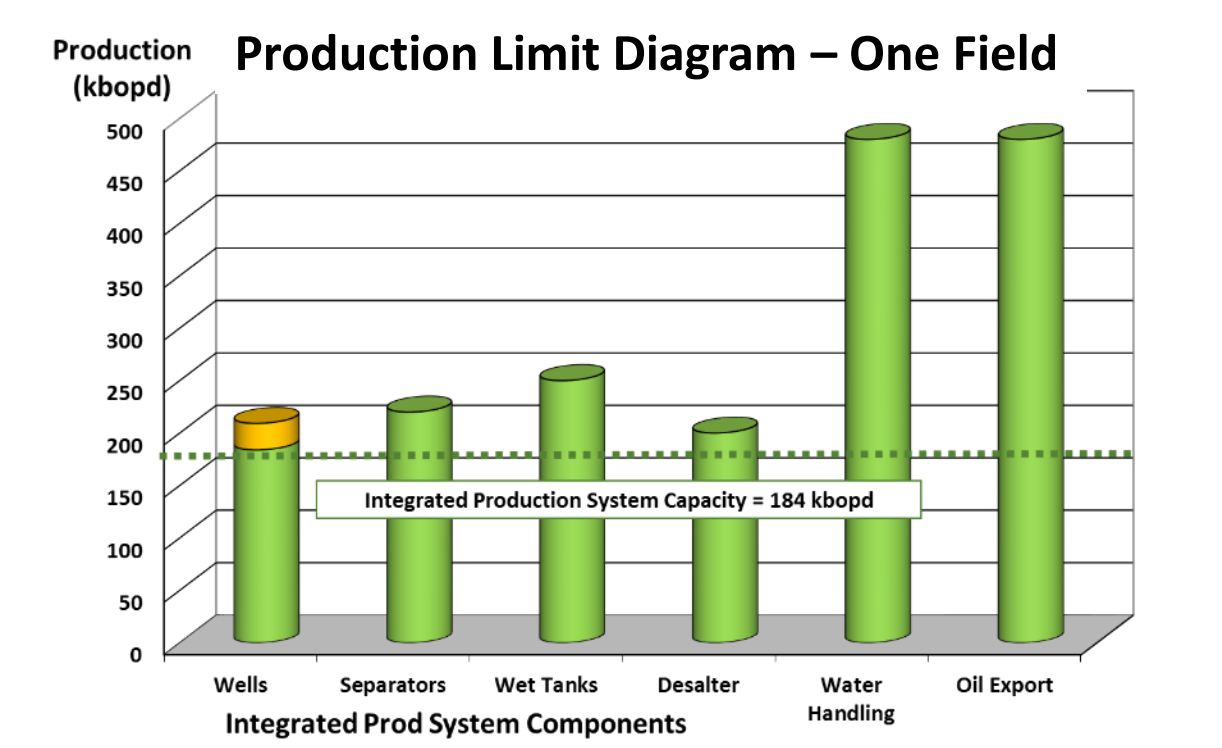


Overrun Analysis

- Reporting planned versus actual analysis (gains, durations, number of activities)
- Deep dive workshop – identify root causes (downtime, change in job objectives, etc.)
- Implement solutions – integrated team (better planning, fixed objectives, equipment availability, etc.)
- 1 day delay is 700 bopd - 10,000's bopd per year

Produce the Limit

- PtL Workshop
- Asset produces 500,000 bopd
- Built a Limit Diagram
- Identify Opportunities
- Break down silos between departments
- Develop implementation plan



Onshore Europe – Major Producer

- Gas wells beaned back - sand production
- Safety and integrity risk
- Sand production transient or continuous?
- Additional costs ($ 100,000's per year):
  - Sand clean-out
  - Install sand screens
- Potential loss of ca. 10,000's m^3/d gas

Sand Conditioning of Gas Wells (Onshore Europe)

- Opened up wells, in steps via test separator
- Monitor sand - is sand transient or continuous
  - If sand transient, bean up
  - If sand continuous, bean back
- Low cost option - minimise sand, maximise gas
- Gains ca. 10,000's m^3/d gas