Elemental Energies

Integrated Subsurface And Facilities Evaluation To Maximise Project Value

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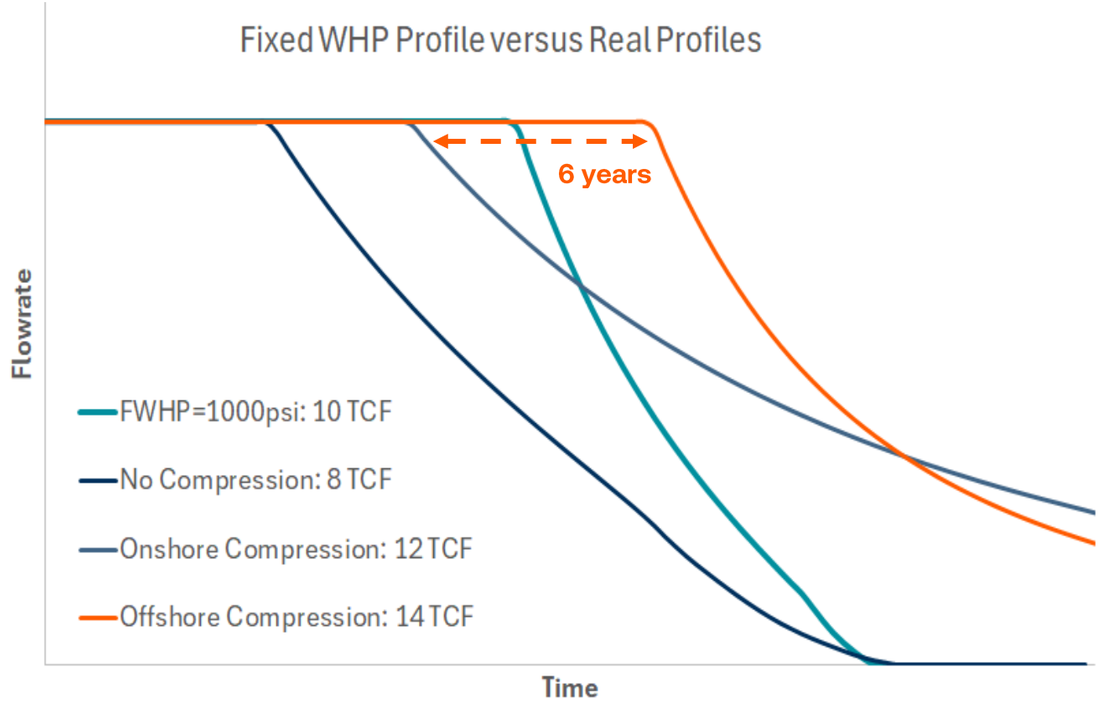
Introduction

Problem Statement

- Common approach – facilities design basis
  - Production profiles & WHPs provided by subsurface taken **as a fixed basis for facilities design**.
- Common approach – subsurface evaluation
  - Subsurface profiles use **oversimplified facilities assumptions**, e.g., a fixed WHP.
- The profile is then :
  - used in the economics
  - given to the facilities team, who provide the costs.
- ***However, the optimal FWHP is not fixed***.
  - Facilities installed & their location ***greatly affects project value,*** especially for gas developments.
  - In the **example**:
    - ***compression increases recovery by 75%***
    - moving compression ***offshore*** adds ***6 years*** to the plateau.

➔ Surface & subsurface workstreams are ***interdependent***

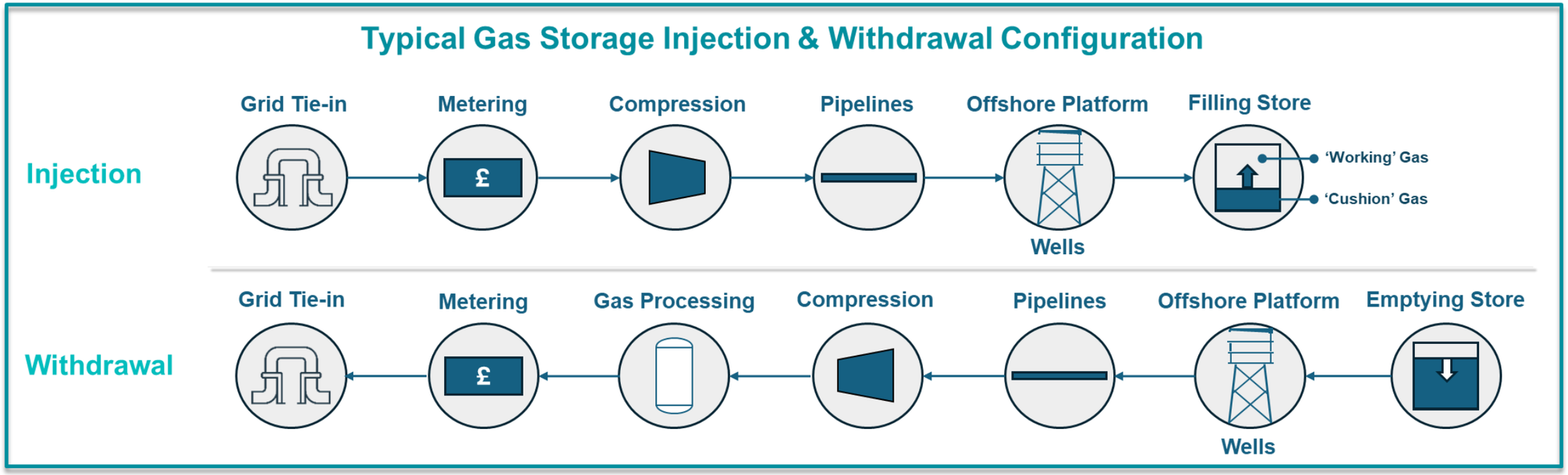
➔ Facilities decisions ***strongly influence production profile & recovery***.



Introduction

Problem Statement

- This presentation shows how a holistic approach to concept optimisation by the Elemental Energies facilities team, integrated with subsurface assessment, produced ***significant improvement in the value of 3 Gas Storage Projects***.
- Projects A & B:
  - **FEL-1 / Assess Phase** optimisation of compression, cushion gas, WHP and pipeline sizes.
- Project C:
  - **FEL-3 (Post-FEED)** optimisation using updated FEED technical information to reduce CAPEX, OPEX & emissions.

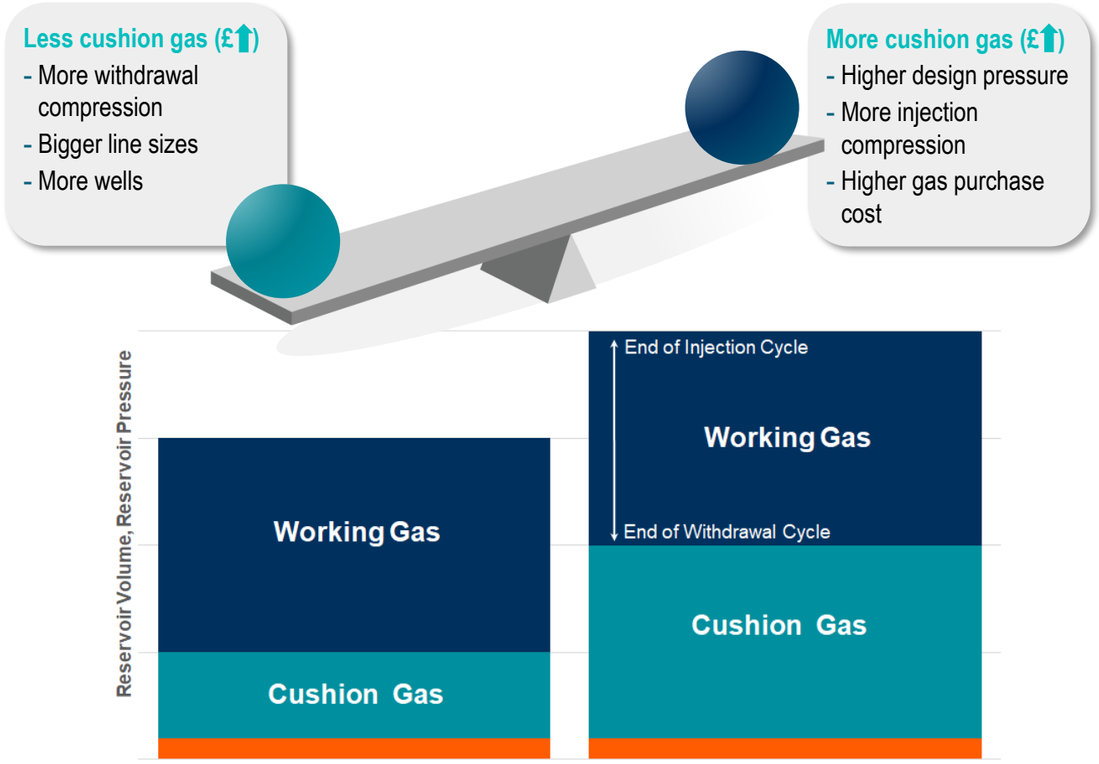


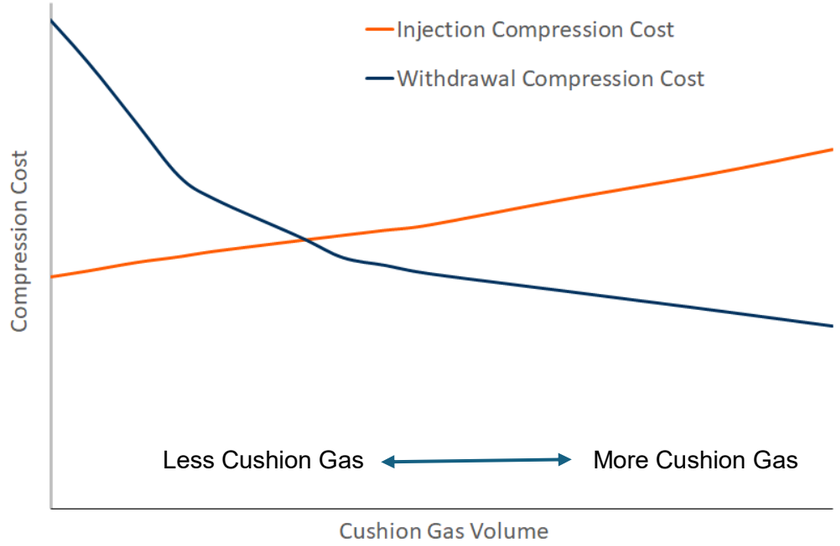
Project A

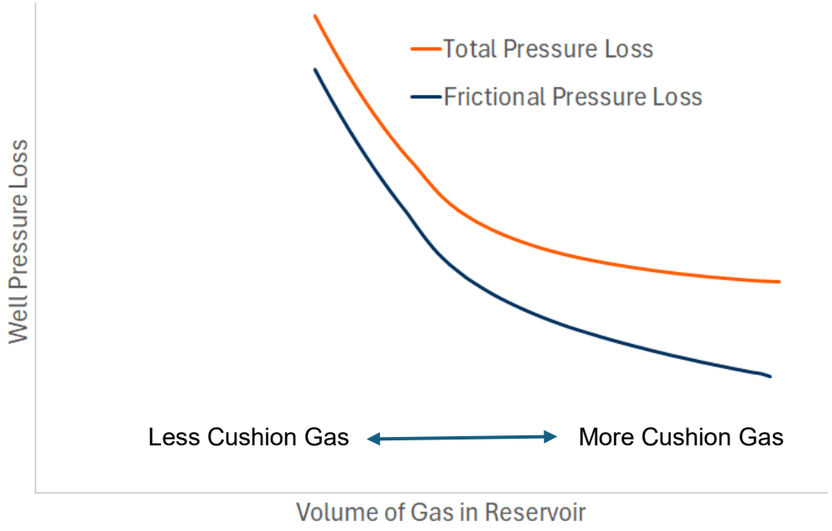
Overview

- Redevelopment of a depleted gas field as gas (& future H_2) store.
- Optimisation performed by varying:
  - compression, cushion gas volume, well count and pipelines configuration to minimise cost & maximise NPV.

For a gas store, total volume of gas = cushion gas + working gas:







Project A

Optimisation Trade-offs

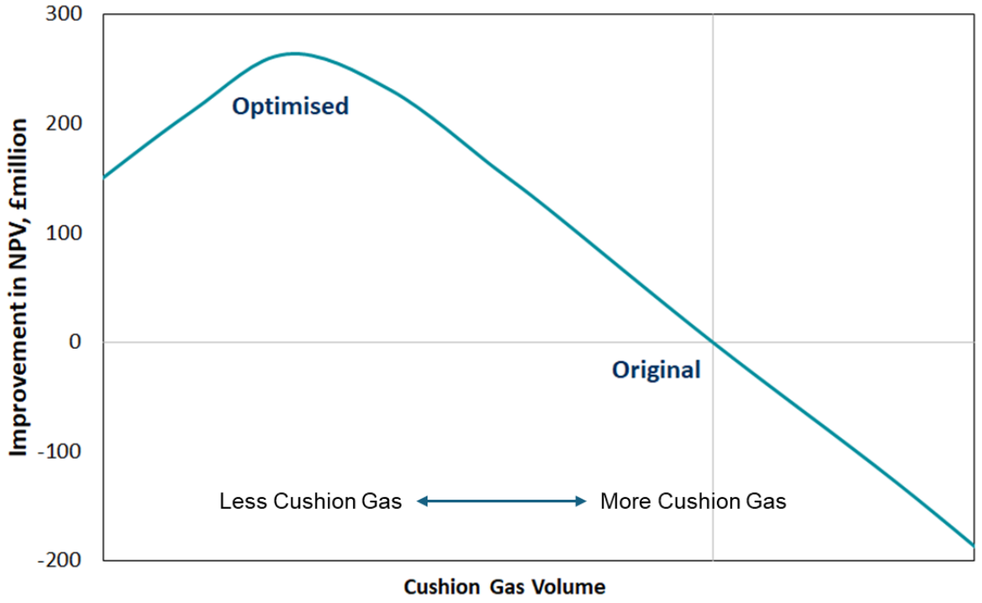
- Sweet spot:

  - cushion gas cost
  - injection compression cost
  - higher design pressures

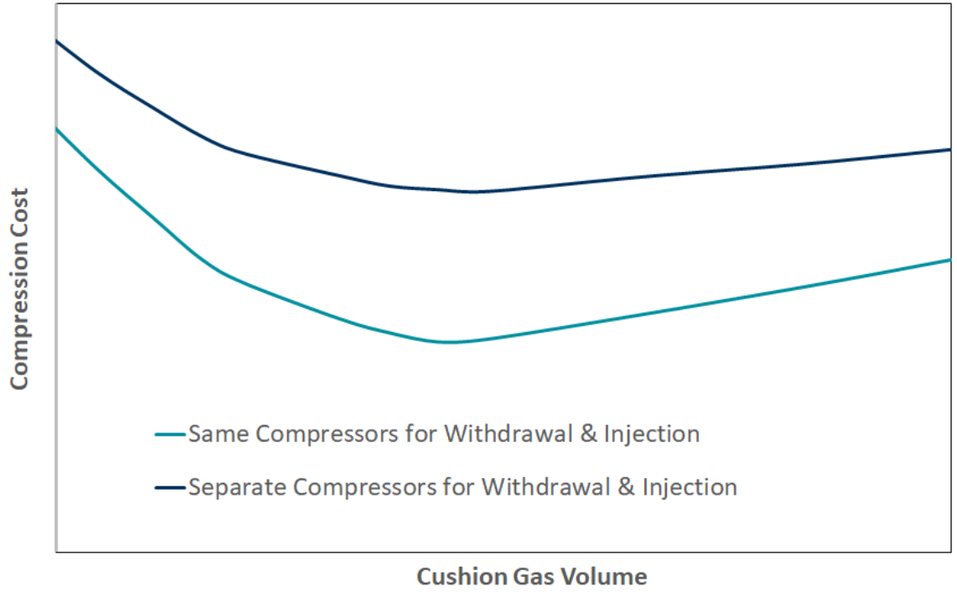
  balanced by

  - withdrawal compression cost
  - well count

➔ Project A ***improved project NPV*** by ***> £250million***.



- Moreover,
  - significant value in using the same compressors for both injection & withdrawal.
- Compression is ***highest contributor*** to ***CAPEX & OPEX.***
- ***Prize:***
  - arrangement of trains & stages that works for ***both injection & withdrawal compression.***

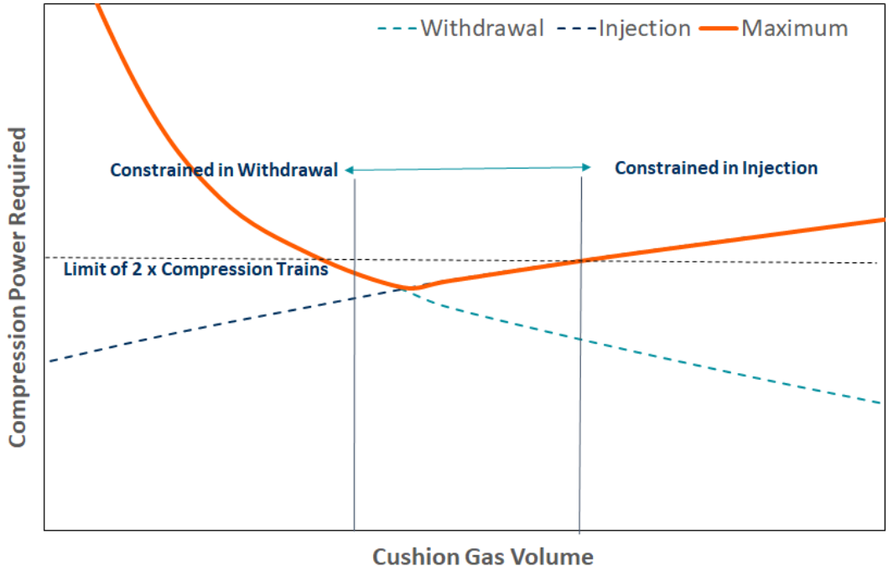


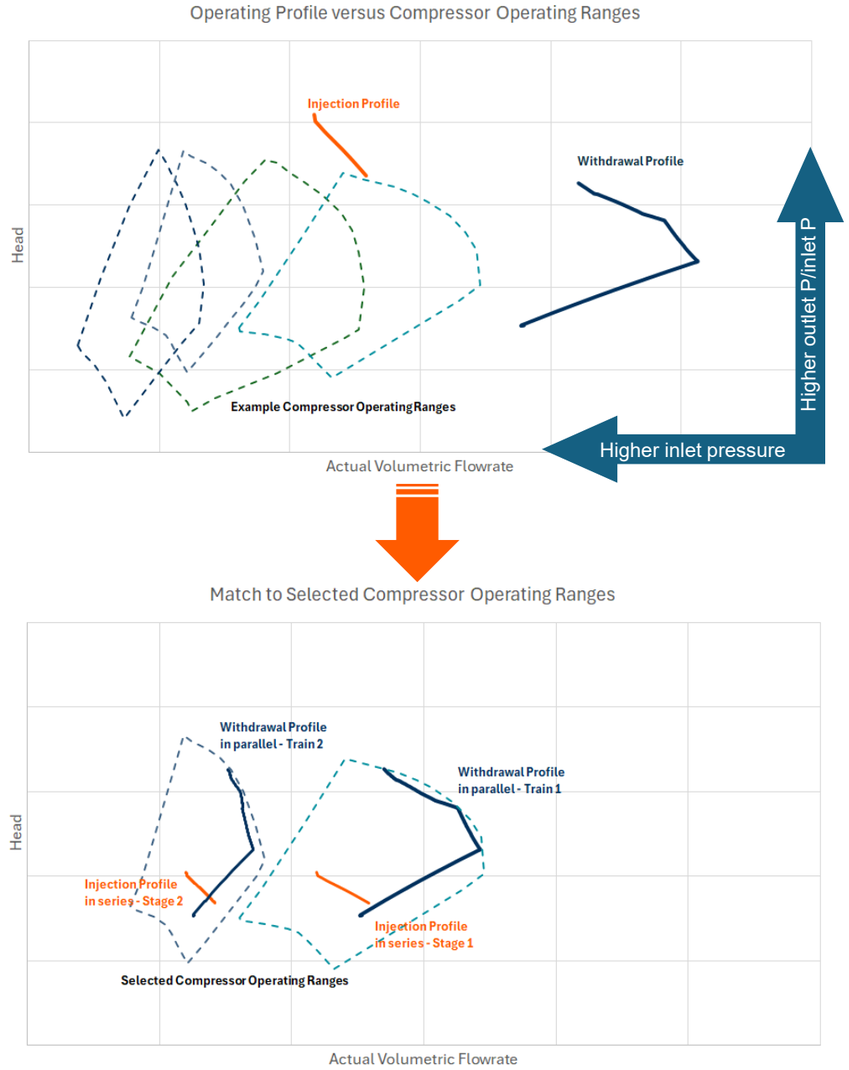
Project A

Optimisation – Compression Arrangement & Operating Point

- Typically, injection pressure is high, requiring higher head.
- Withdrawal typically operates at lower pressures (high vol. flowrates).
- ***Solution:***
  - compressors in ***series*** for injection, in ***parallel*** for withdrawal.

- Further constraint is driver power: more compressor trains ➔ more cost





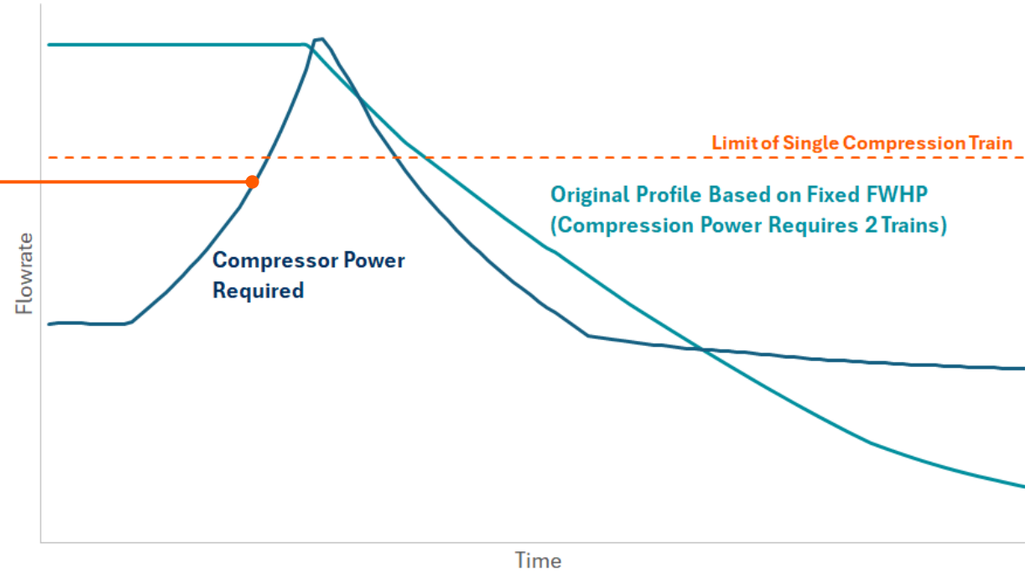
➔ ***Two compressors for both injection & withdrawal saved ~£100million***.

Project B

Overview

- Redevelopment of small gas accumulation (previously a single well tieback) as a gas store.

- Original withdrawal profile, WGV and cushion gas volume were based on **fixed WHP**.
  - This requires 2 trains of compression.
  - Fixed WHP does not use compressors efficient



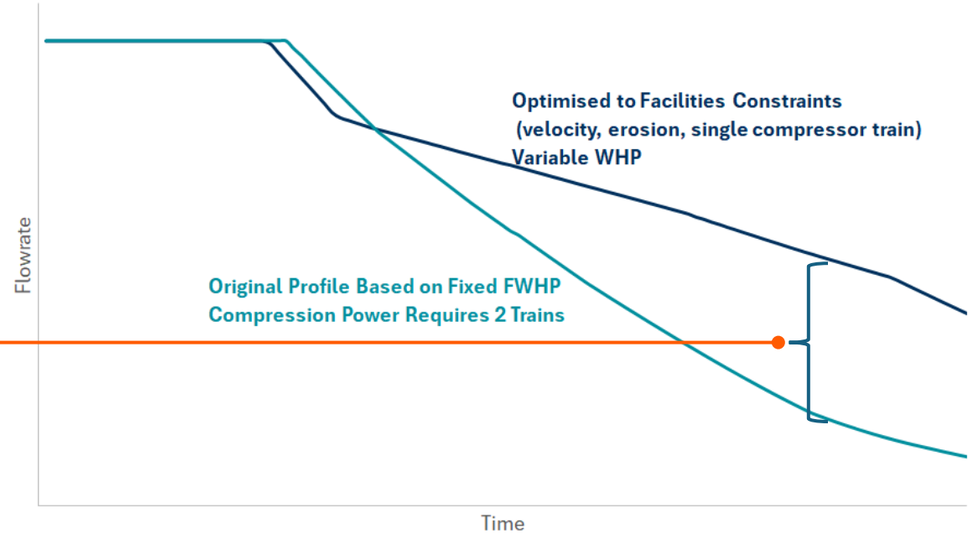
- ***Optimisation***:
  - Remove fixed WHP and ***establish production profiles based on facilities constraints***.
    - Max size of motor to drive ***single train of compression***
    - Compressor envelope - (head, vol. flowrate) limits
    - Varying well count - pressure loss and erosion limits
    - Varying pipeline size - pressure loss and velocity limit

Project B

Optimisation – Compression Arrangement & Operating Envelope

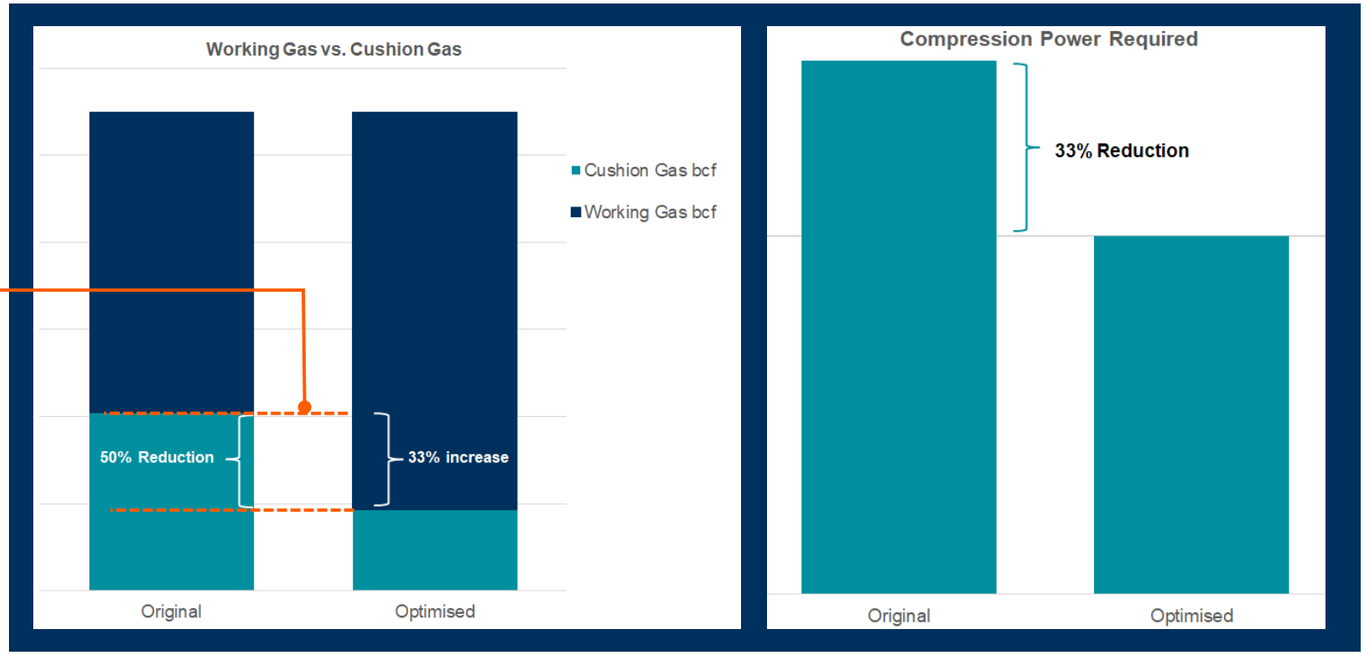
Optimisation Outcome:

- With fixed WHP removed, reducing from 2 compressor trains to 1 ***still improves production profile***
- Adding or removing wells did not improve value.



Prize:

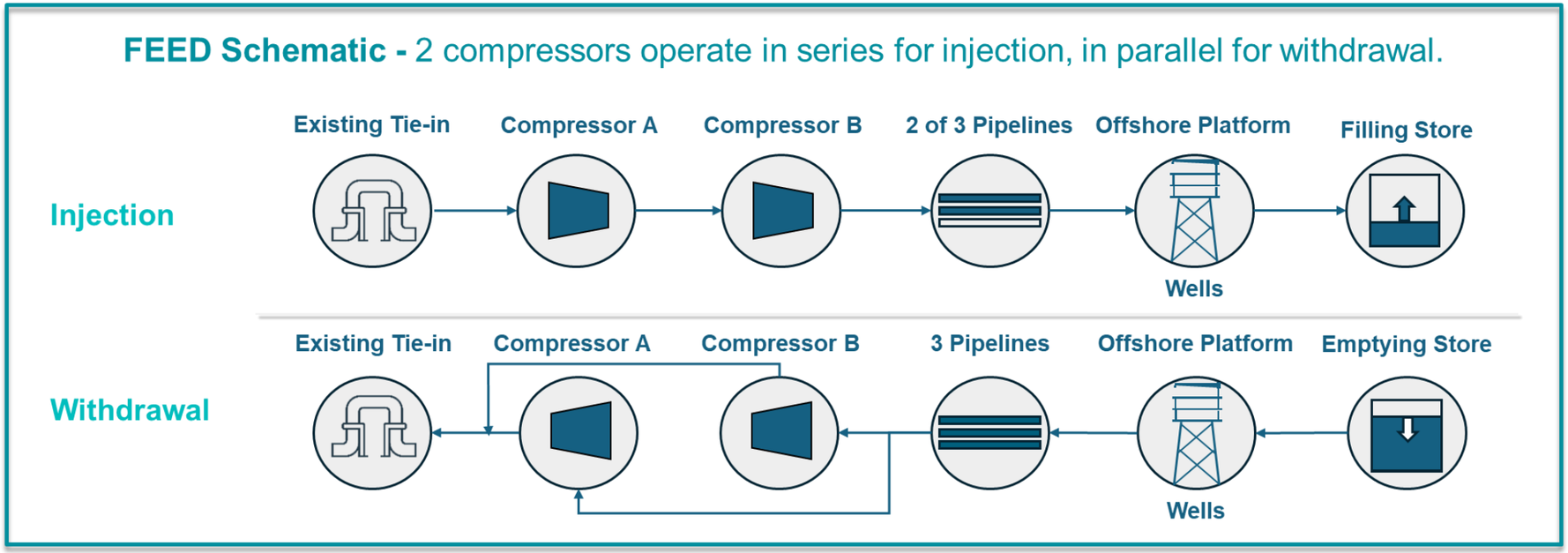
- ***>20% saving in gas plant cost.***
- ***> £100million overall CAPEX saving.***
- ***50% cushion gas cost saving.***
- ***33% increase in working gas.***



Project C

Overview

- Post-FEED project value improvement
- Revisiting operating envelopes/profiles, and compression & pipelines operation based on updated technical information from the FEED.
- **Objective:** to ***reduce*** project ***CAPEX***, ***OPEX*** & ***emissions***.



Original FEED design basis was **conservative** to ensure within multiple compressor vendors capability

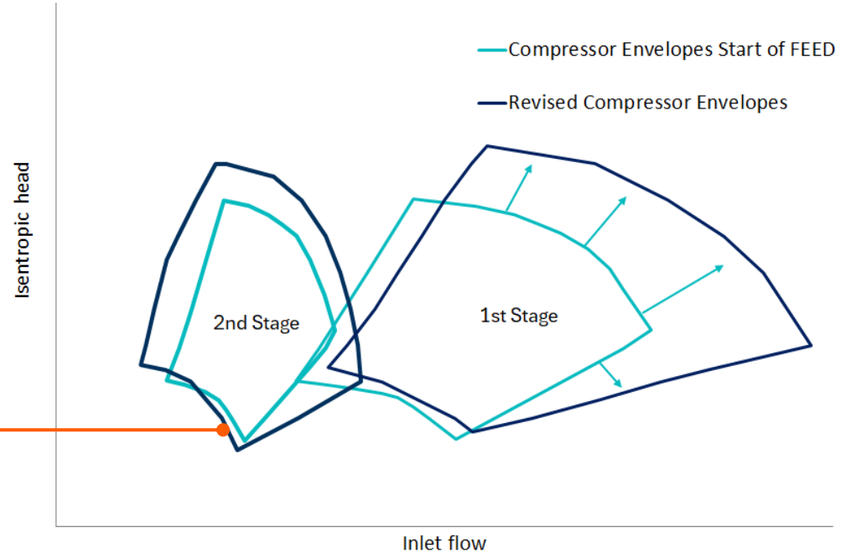
- Value improvement by ***refining withdrawal & injection profiles***, for revised FEED information on compressor envelopes, driver size & compressor efficiency.

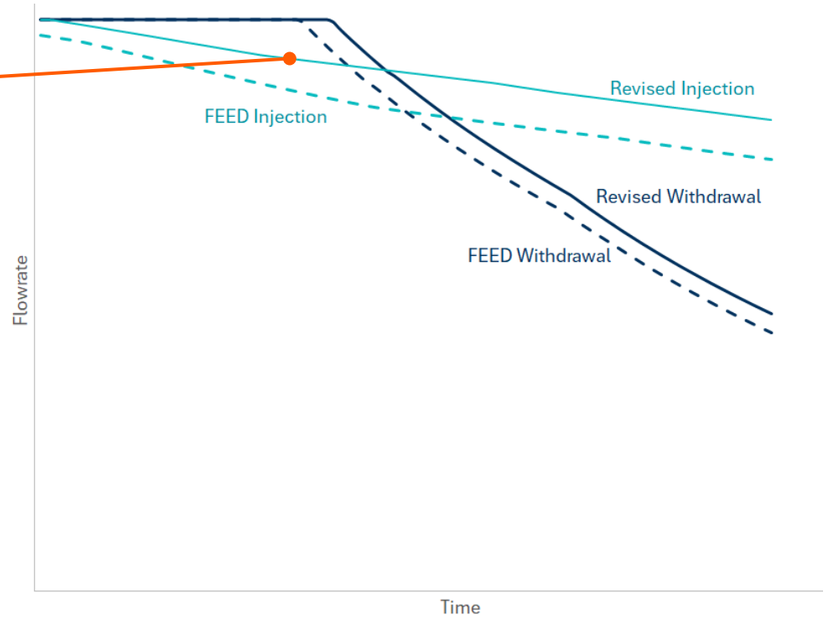
Project C

Optimisation Opportunities following FEED

- Actual compression selected during FEED :
  - ***10% more*** driver power than FEED basis.
  - ***5% higher*** average compressor efficiencies than FEED assumption.
  - Larger compressor envelopes than FEED design assumption.

- Introduced opportunities:
  - quicker withdrawal & injection
  - lower FWHP.
- Profiles generated with revised compression have ***5% higher flowrates***.





Key value improvement opportunities :

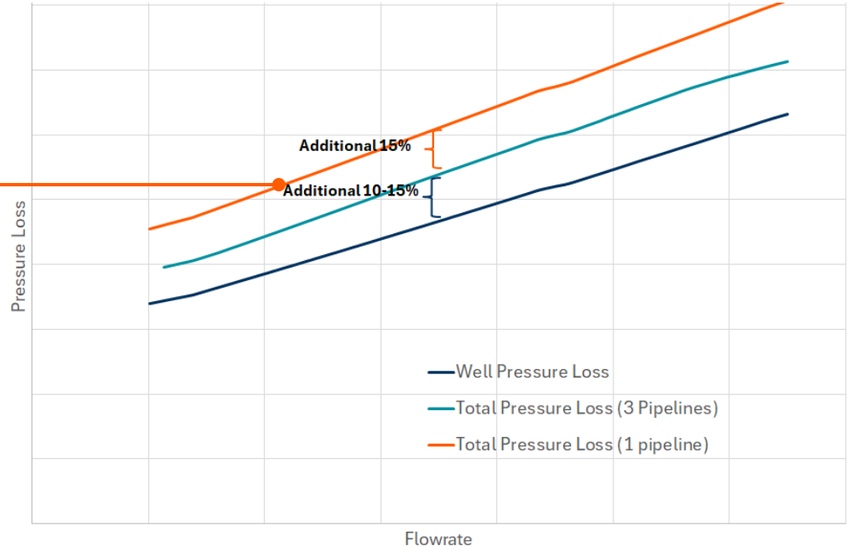
- Investigate impact on production profiles of:
  - Fewer/smaller pipelines ***to save CAPEX.***
  - Operation with one compressor only during withdrawal ***to save OPEX & emissions.***

Project C

Post FEED Optimisation – Pipeline Configuration & Compression Operation

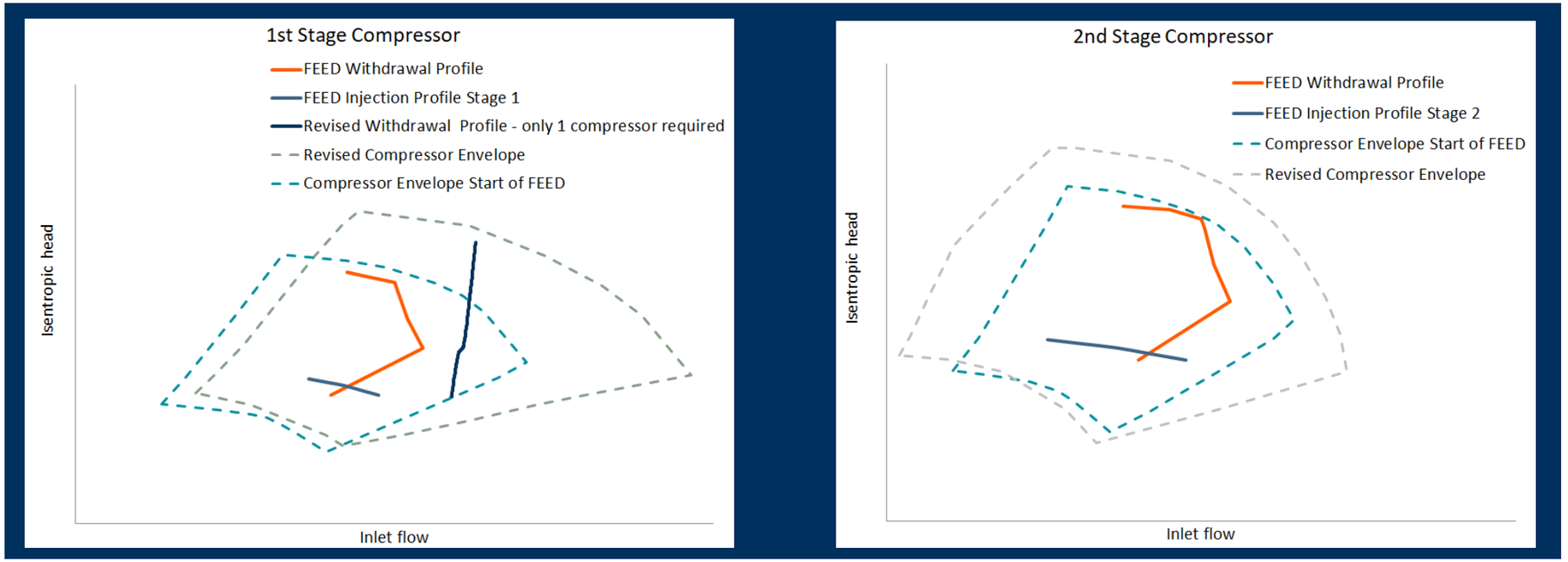
Value Improvement Opportunity – Pipelines CAPEX Reduction

- In withdrawal, 85-90% of the pressure loss is in the wells, little loss in pipelines.
- With improved compression, there is scope for increased pipeline pressure loss.
- Reducing from ***3 pipelines to 1*** only adds ***15%*** to total pressure loss.



Value Improvement Opportunity – Compressor OPEX Reduction

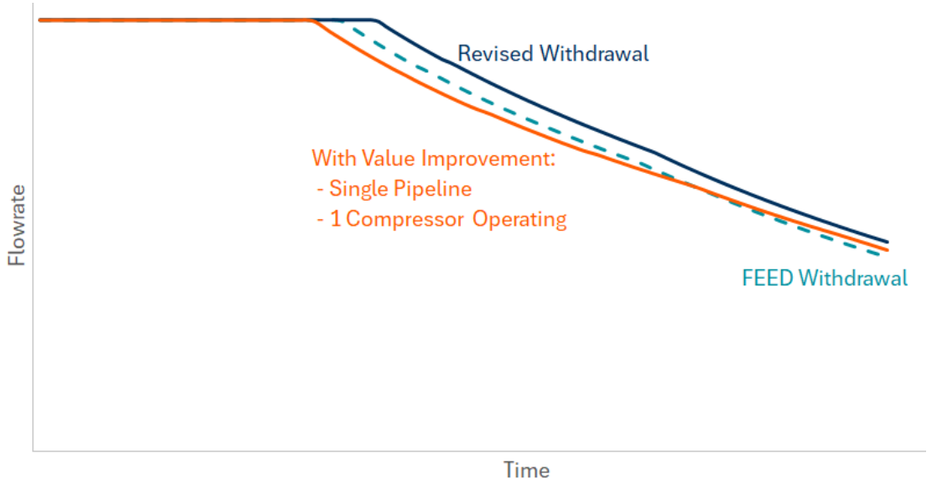
- With larger compressor map, max flow can be accommodated in ***one compressor***, ***saving fuel and emissions***.

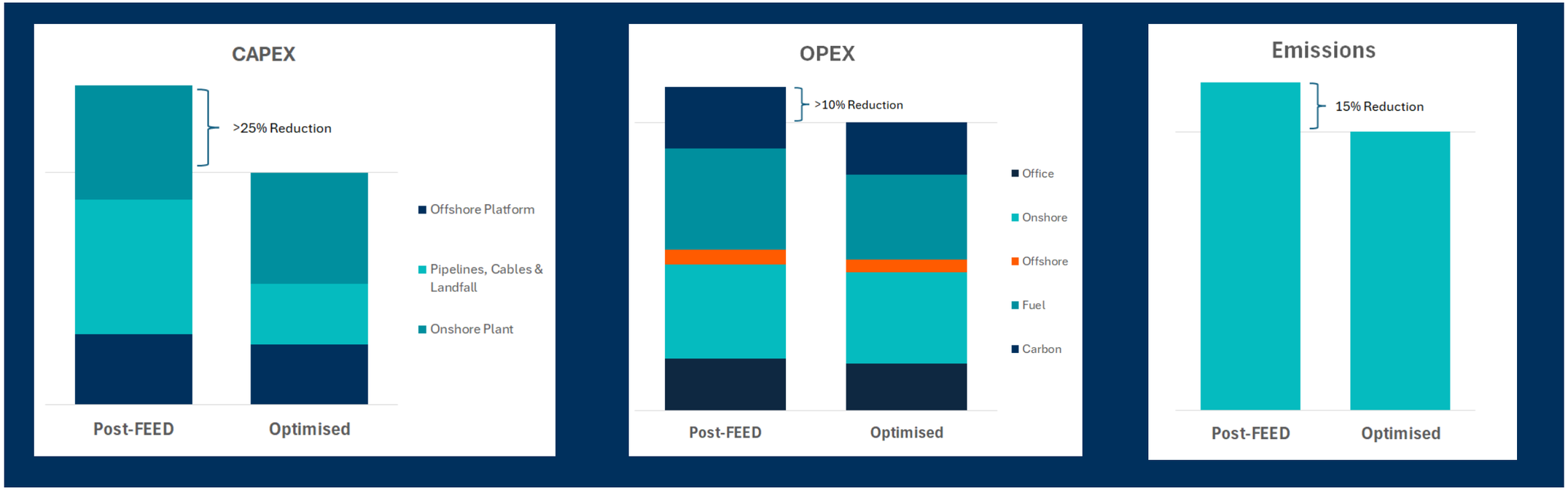


Project C

Post FEED Optimisation – Pipeline Configuration & Compression Operation

- Orange line is revised “Value Improved” withdrawal profile with:
  - reduced CAPEX (only 1 pipeline)
  - reduced OPEX & emissions (only 1 compressor in withdrawal)
- Comparable to initial FEED profile (& the injection profile is better).
- ***Significant potential savings*** achieved in CAPEX & OPEX, ***even after FEED:***





Summary

Holistic Concept Optimisation

- These 3 gas storage projects illustrate how a ***holistic approach to concept optimisation***, integrating subsurface & facilities evaluation, can provide a ***substantial benefit to project economics***.
- Project A: optimisation of compression, cushion gas volume, well count & pipelines:
  - ***improved project NPV by >£300million.***
- Project B: optimisation of FWHP, compression & pipelines by Elemental's facilities team:
  - ***improved working gas volume by 33%,***
  - ***reduced project CAPEX by >£100million***.
- Project C: optimisation of compression operation, pipelines & flow assurance potentially reduced:
  - ***CAPEX by >25%***
  - ***OPEX by >10%***
  - ***Emissions by 15%***
- For all 3 projects, ***clear economic benefit achieved through integration of surface facilities & subsurface assessment.***

This is valid not just for gas storage projects, but for many others - especially for gas developments.

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Thank You

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