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# Optimizing Hydrocarbon and Energy Management in Upstream Oil and Gas Operations

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**International Gas Union Research Conference (IGRC)**
**September 17-19, 2014**
**Copenhagen Denmark**

1914 - 2014 | A Century of Innovation in the Oil and Gas Industry

# Roadmap

- **Hydrocarbon Management: Definition and Relevance**
- **How Good HC Management Creates Value**
- **Case Studies**
  - Advanced Process Control for Upstream
  - Flare Reduction with Small Scale LNG Solution
  - Fuel Gas Conditioning for Remote Power Gen
  - Increase HC Recovery from EOR Operations
  - Staged Expansion to Match Field Development
- **Summary**

# Hydrocarbon Management Principles

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## *What?*

- **Systems approach**
- **Look across all phases of the project and the value chain**
- **Understand which molecules are coming in**
- **Efficiently route molecules to right products and maximize total value**
- **Avoid system losses if there is economic payout**
- **Gain, sustain, maintain**

  (continuous improvement)

## *Why?*

- **Improve profitability**
- **Better yield on hydrocarbon reserves**
- **Reduce environmental footprint and costs**
- **Achieve sustainable best practices accepted by stakeholders**
- **Flexibility to adapt to changing markets, inputs, and technologies**

# Decision Factors in O&G Project

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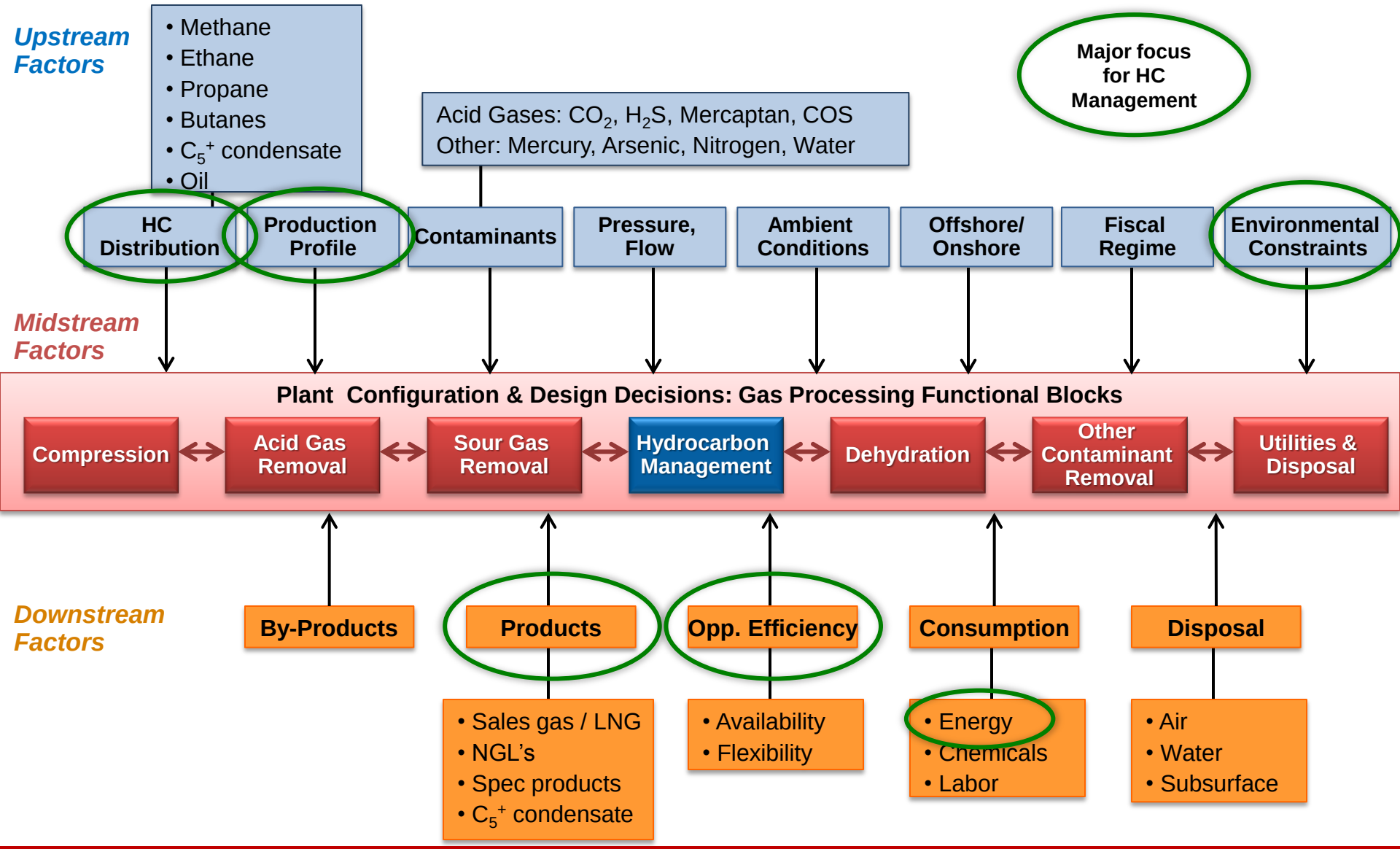


**HC Management is Core to Getting Right Project & Right Results**

# Value Creation with HC Management

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## *Multiple Value Sources*

1. **Avoiding value "give away" due to operating in a very conservative way**

   Advanced Process Control for Upstream

2. **Avoiding emissions and emission related costs from "hydrocarbon burn"**

   Flare Reduction with Small Scale LNG

3. **Avoiding energy purchase**

   Fuel Gas Conditioning for Remote Power Gen

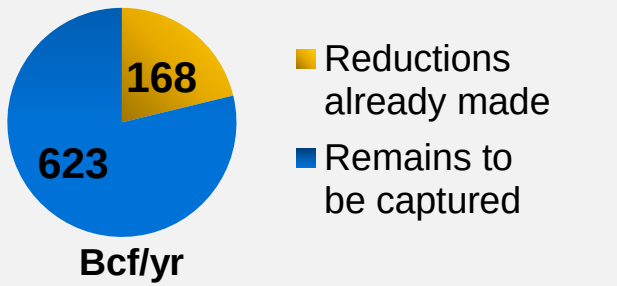
4. **Incremental revenue from recovering hydrocarbons that would be lost**

   Increased HC Recovery from EOR Operations

5. **Optimized investments in technology for recovery of higher value products to deal with uncertainty**

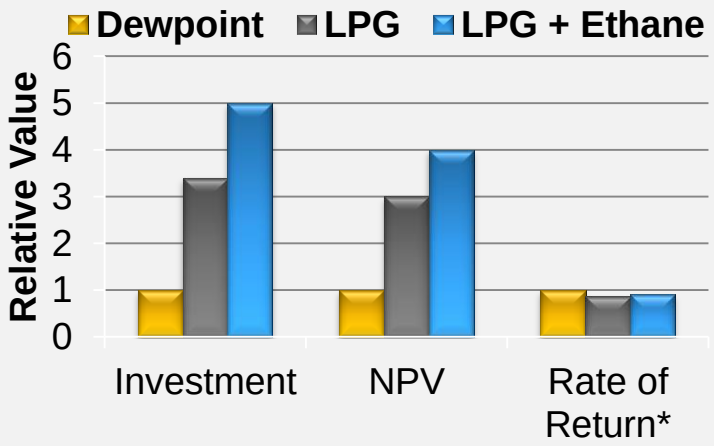
   Staged Expansion to Match Field Development

### 2011 O&G Industry Methane Losses (U.S.)




**Value of lost HC is $2.5B per yr (based on $4.00 / mmbtu)**

### Recovery of high value products




**return on gas plant investment*

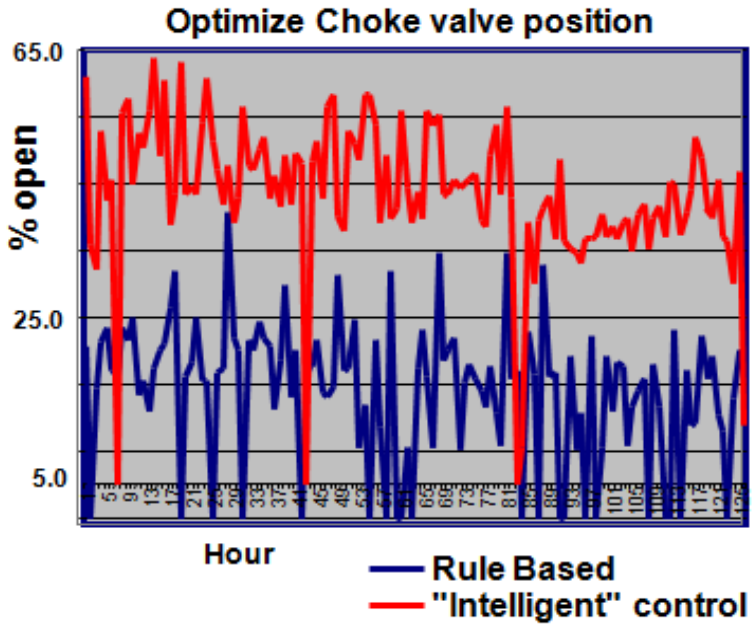
# Advanced Process Control for Upstream

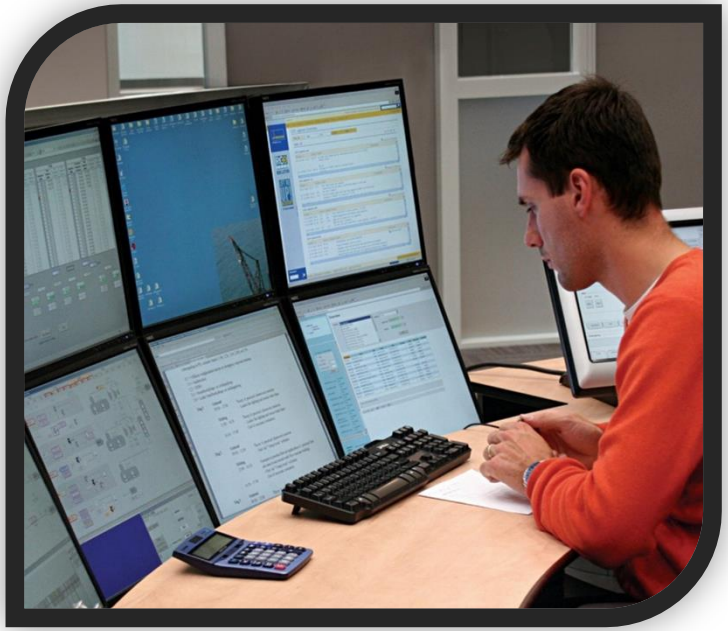
## Situation

Unstable upstream process operations lead to unplanned shutdowns of production and increased operational complexity

## Challenges or problem

A vast array of upstream data are captured but cannot be used to effectively manage and optimize operations without integration and advanced control schemes



# Advanced Process Control for Upstream

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## Solution

Implement advanced control schemes to reduce downtime and consequences

## Benefit relative to non-integrated approach

- Upstream offshore choke intelligent controls stabilize production and simplify operations, and may increase production by ~ 2 to 5% and revenue by ~ $20M per year for a 45 kbpd platform vs. rules-based ops
- Advanced controls commissioned for upstream separator operations may increase production by up to 6%, yielding over $10M/year additional revenue for a 45 kbpd platform as a result of fewer shutdowns

**Kpbd = thousand barrels per day*

# Flare Reduction with Small Scale LNG Solution

## Situation

A cluster of conventional oil wells in a development area produce 467 Mcm (16.5 MMcf) of associated gas per day, which is simply flared

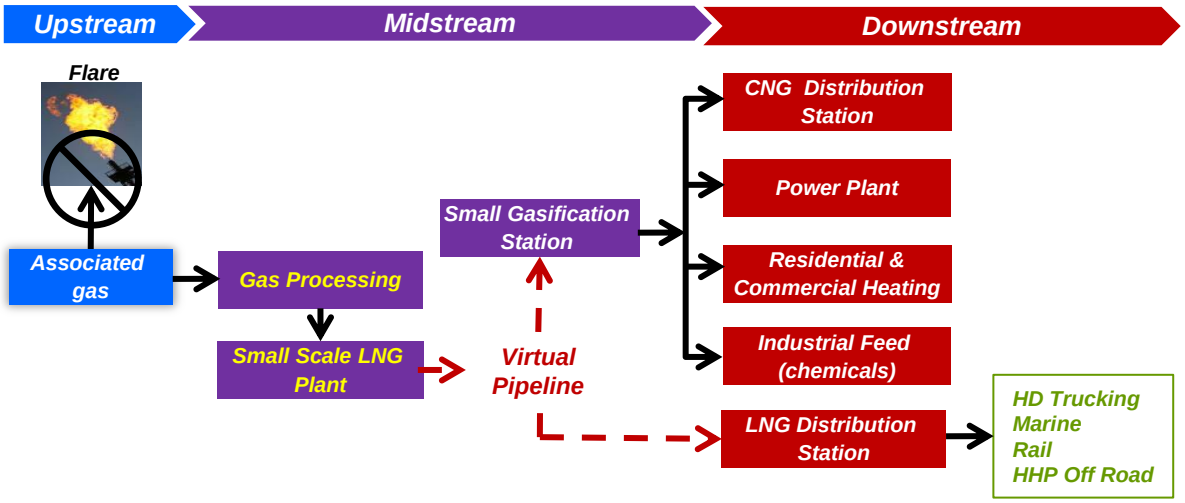
## Problem

- Due to the remote location of the oil field, it is not economic for the operator to justify the cost of building the pipelines and other infrastructure to capture and deliver the fuel as a gas to consumer markets.
- 170.5 MMcm (6 Bcf) of natural gas is flared annually from this development area, wasting approximately $34.8 Million

## Solution

Small Scale LNG

Monetize the associated gas by liquefying it and transporting the fuel to consumer markets via a “virtual pipeline” i.e. truck or rail



# Flare Reduction with Small Scale LNG Solution

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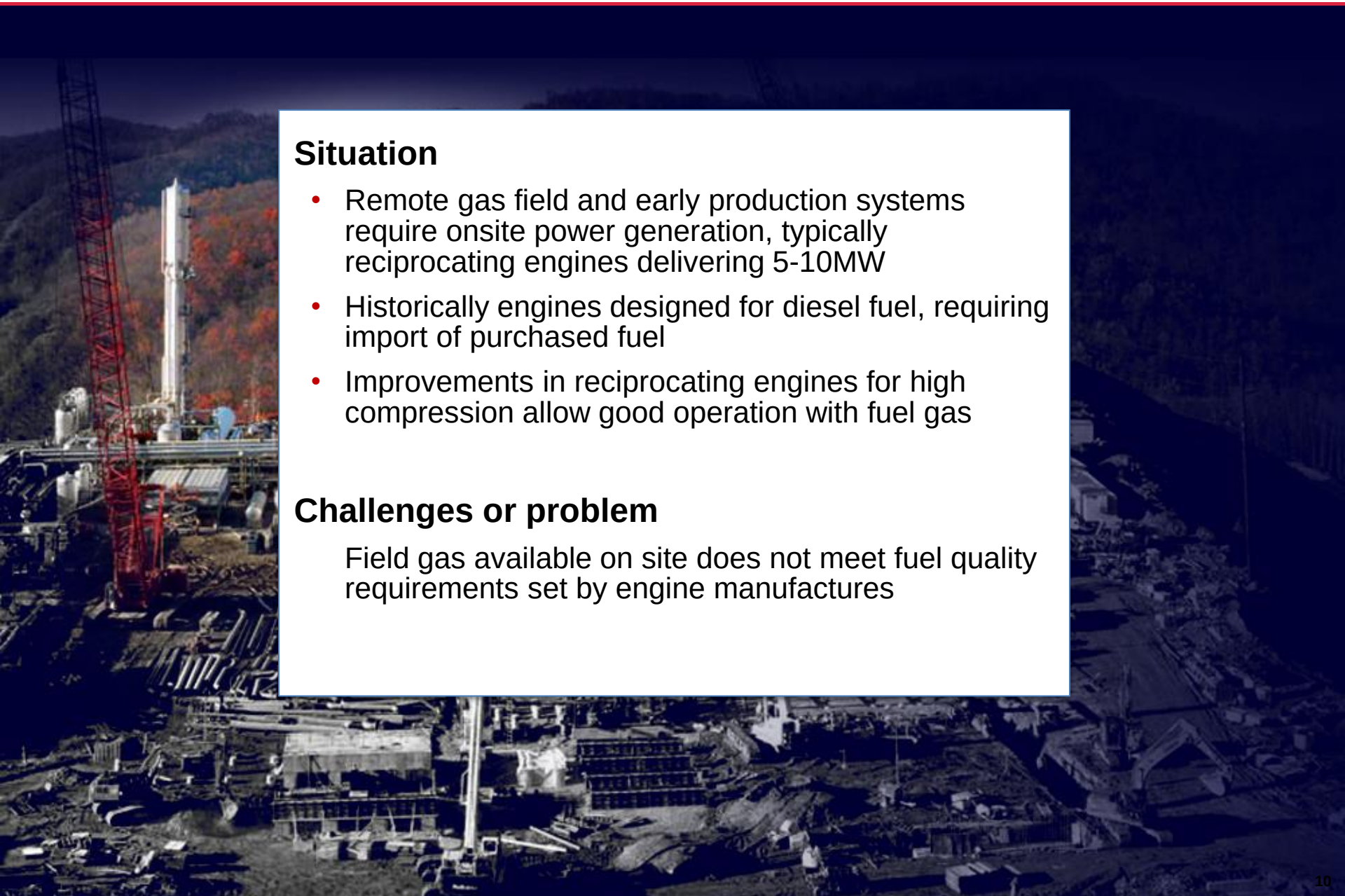
## Potential Benefit/Economics

- Plant investment of $55.6 M
- Investment in a gas collection system is necessary. $10 M with expected payback < 2 yrs
- Plant Economics (IRR) are favorable under following operating conditions

| 200,000 gal per day plant | Project Scenarios Low | Mid | High | High Elec |
|---|---|---|---|---|
| Electric Power ($/kWhr) | **$0.05** | **$0.055** | **$0.06** | **$0.08** |
| Pipeline Gas ($/MSCF) | **$2.50** | **$3.75** | **$5.00** | **$5.00** |
| CAPEX/gal of LNG (¢/gal) | **7.85** | **7.85** | **7.85** | **7.85** |
| DGE | 13.15 | 13.15 | 13.15 | 13.15 |
| OPEX/gal of LNG (¢/gal) | **7.68** | **8.29** | **8.91** | **10.66** |
| DGE | 12.86 | 13.89 | 14.92 | 17.86 |
| Total Cost ¢/gal of LNG (*Excl NG Feed*) | **15.53** | **16.15** | **16.76** | **18.52** |
| DGE | 26.01 | 27.05 | 28.07 | 31.02 |
| IRR (EBITDA) | **26%** | **20%** | **13%** | **12%** |

***Assumptions & Conversions:***
***Operating rate = 80% of plant capacity; 15 yr plant life; LNG sales price = $0.95.; discount rate=10%***

# Fuel Gas Conditioning for Remote Power Gen



## Situation

- Remote gas field and early production systems require onsite power generation, typically reciprocating engines delivering 5-10MW
- Historically engines designed for diesel fuel, requiring import of purchased fuel
- Improvements in reciprocating engines for high compression allow good operation with fuel gas

## Challenges or problem

Field gas available on site does not meet fuel quality requirements set by engine manufactures

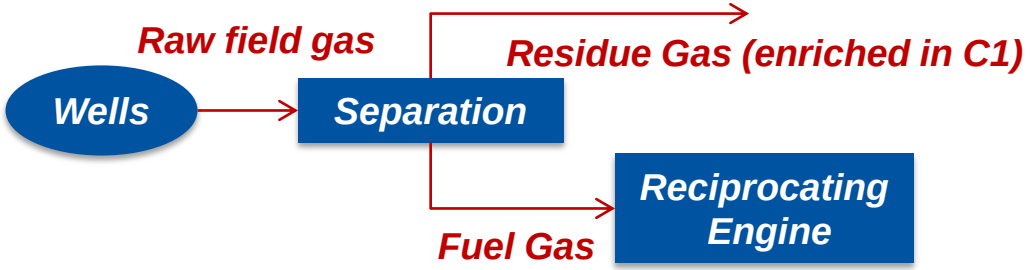
# Fuel Gas Conditioning for Remote Power Gen

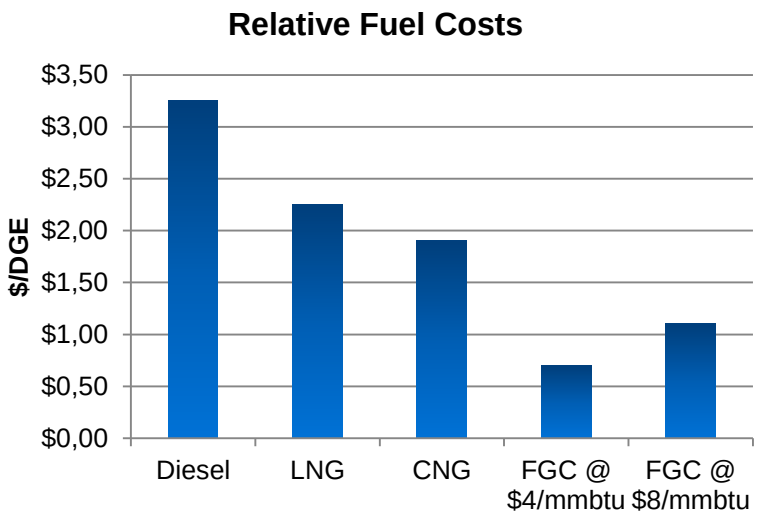
## Solution

- Upgrade fields gas with dedicated fuel conditioning unit
- Utilize UOP Separex™ Membrane Separation to generate high quality methane fuel
- Allows for direct diesel substitution

## Benefits relative to alternative fuels

- Lower fuel cost (diesel vs. conditioned field gas)
  - ~$3.50 vs $1.0 / DGE or ~$4M savings per year for 3.5 MW engine as full capacity
- Lower overall emissions and after engine control costs
- Rich gas stream from membrane system available at tailored pressure
- Higher overall engine efficiency due to high compression engine design



# Increase HC Recovery from EOR Operations

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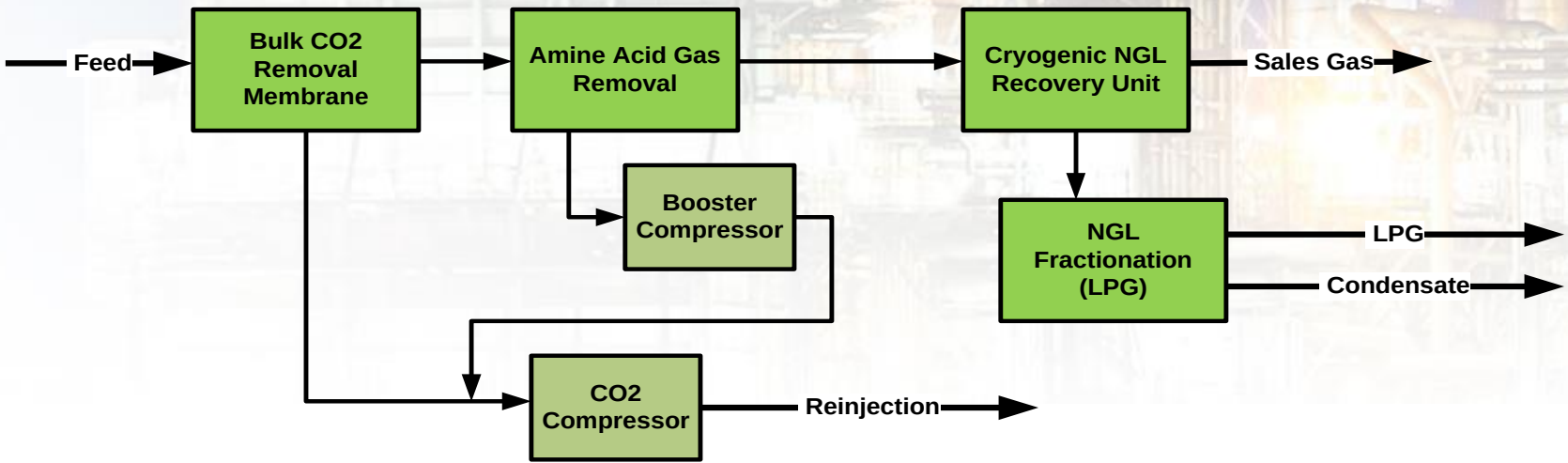
## Solution

- Bulk CO2 removal with membranes which can be easily adjusted over the life of the project
- Solvent (Amine) based CO2 removal to pipeline specs
- Flexible Cryogenic NGL recovery
  - C2 recovery or rejection.
  - Option for CO2 Tolerant cryogenic unit
  - Option for NGL fractionation



# Increase HC Recovery from EOR Operations

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## Benefit of integrated EOR operations

- Continue to process all the gas as CO2 increases over time
- Phased investment in membrane capacity is small compared to capital projects to increase capacity
  - As CO2 increases, the total feed to the plant can be increased and the feed to the Amine unit and NGL recovery unit can be held essentially constant
- Membrane permeate provides higher suction pressure to CO2 compressors

# Increase HC Recovery from EOR Operations

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## Situation

- Enhanced Oil Recovery (EOR) applications with high CO2 gas feed
- Objectives: Recover CO2 for re-injection and recover NGL and pipeline gas for sale

## Challenges or problem

- CO2 content continuously increases over the life of the project (e.g. from 25% to 50%+)
- Cryogenic NGL recovery plants are susceptible to CO2 freeze
- CO2 compression requires a large amount of power

# Staged Expansion to Match Field Development

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## Situation

- Gas field in development with staged production
- Plateau production rate requires 1.2 bcfd processing capacity
- Cash flow from project needed to minimize financing

## Challenges or problem

- Less than 200 mmscfd gas available initially
- Conventional approach for stick-build (field erected) would be 1 or 2 trains (600 mmscfd)
  - Large train at limit of turndown, reduced reliability
  - Significant delay in plant startup extends schedule
  - High initial investment required, field still not proven, high risk

# Staged Expansion to Match Field Development

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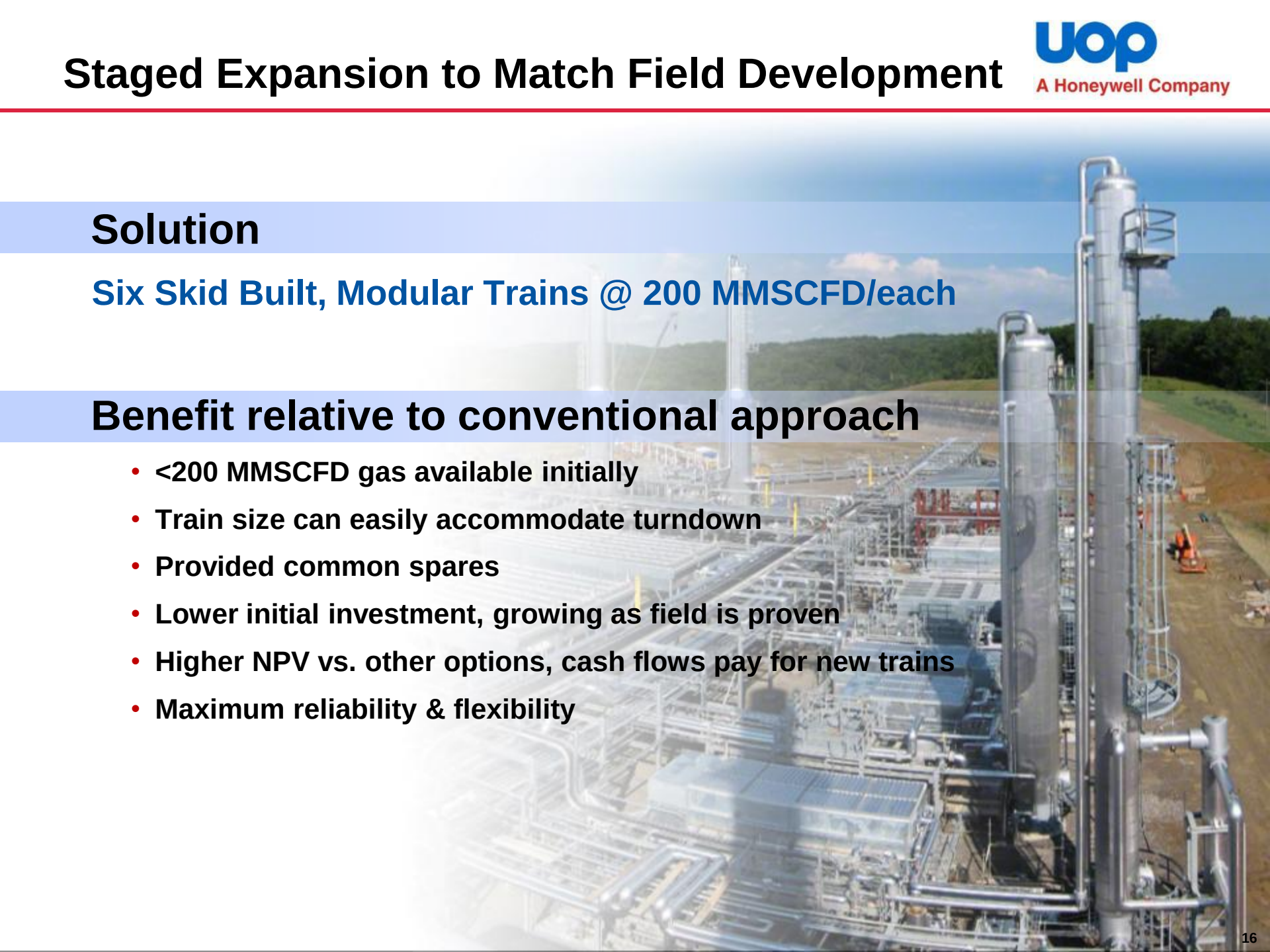
## Solution

**Six Skid Built, Modular Trains @ 200 MMSCFD/each**

## Benefit relative to conventional approach

- **<200 MMSCFD gas available initially**
- **Train size can easily accommodate turndown**
- **Provided common spares**
- **Lower initial investment, growing as field is proven**
- **Higher NPV vs. other options, cash flows pay for new trains**
- **Maximum reliability & flexibility**



# Summary

- **Difficult situations require new solutions**
  - Remote locations
  - Infrastructure lacking
  - Flexibility due to changing conditions and uncertainty
- **Several Applicable Technologies in the tool box:**
  - Cryogenic separations
  - Refrigeration
  - Adsorption
  - Modular plant design
  - Advance Process Control
  - Thermal Oxidation systems
  - Membranes
- **Examples demonstrate value of integrated and planned approach**
- **Identify and invest in projects where better HC management yields higher overall project ROI**


Q&A
Question and Answer