MUNRO, G., IYALLA, I. and MAHON, R. 2024. Reducing North Sea emissions using cost-effective field layout strategies. Presented at the 2024 Subsea expo, 20-22 February 2024, Aberdeen, UK.

Reducing North Sea emissions using cost-effective field layout strategies.

MUNRO, G., IYALLA, I., and MAHON, R.

2024

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Reducing North Sea Emissions Using Cost-Effective Field Layout Strategies

Grant Munro, Dr Ibiye Iyalla, Dr Ruissein Mahon

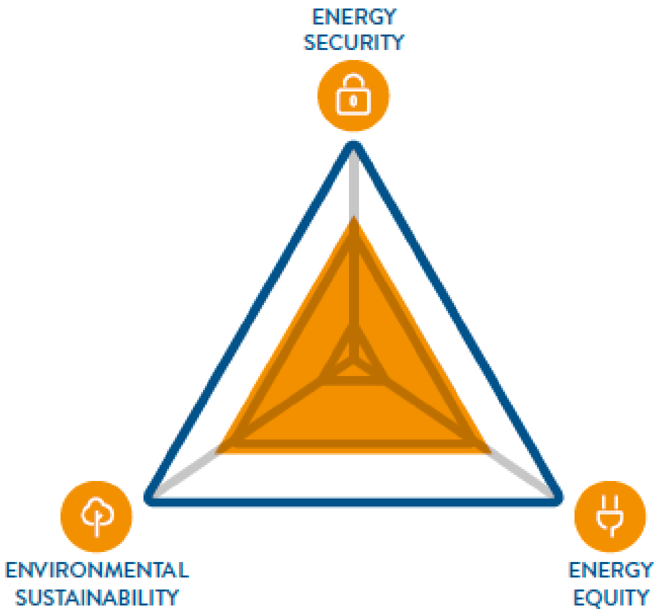
Subsea Expo

Diversification: Opportunity through Evolution

22nd February 2024

Balancing the Energy Trilemma

Sustainable Development Goals (United Nations, 2016)



The Energy Trilemma (World Energy Council, 2022)

To achieve the Paris Agreement's Net Zero emissions targets by 2050, reducing GHG emissions and carbon footprint is currently at the forefront operators' strategies for new and existing field layouts in the North Sea.

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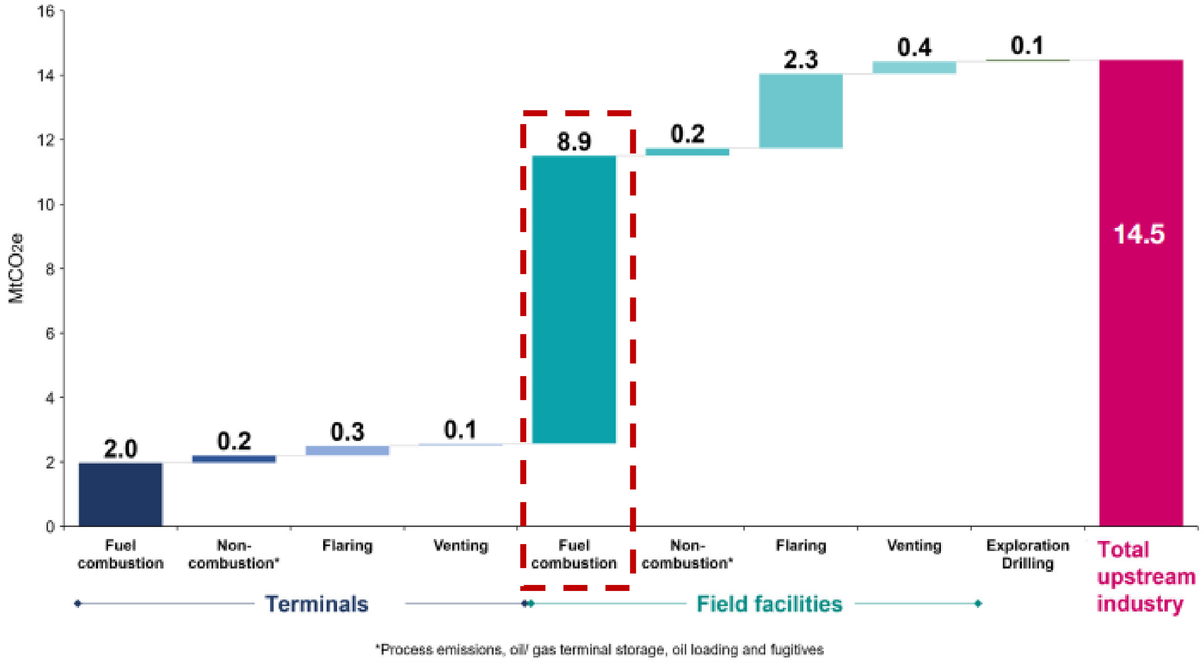
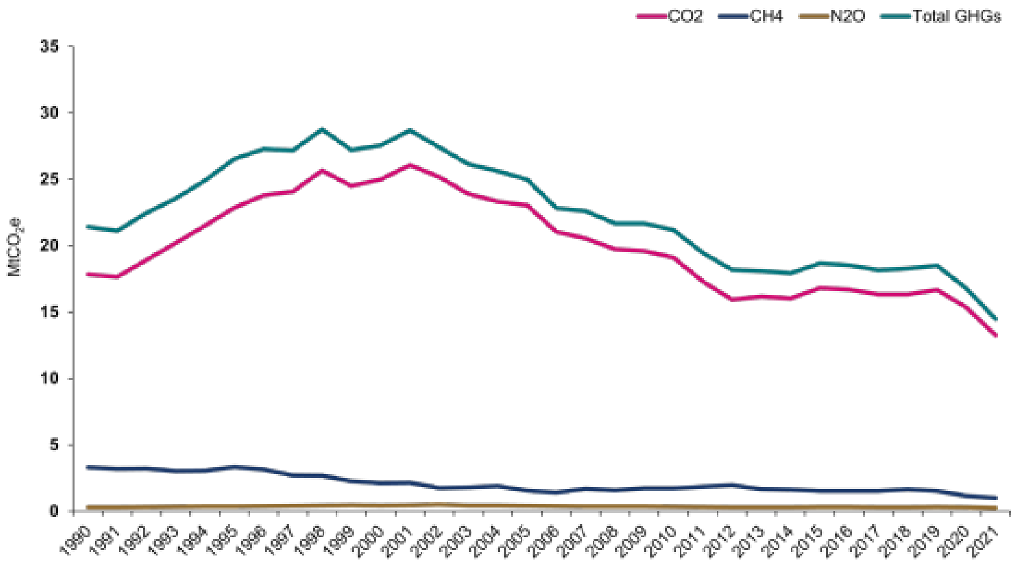
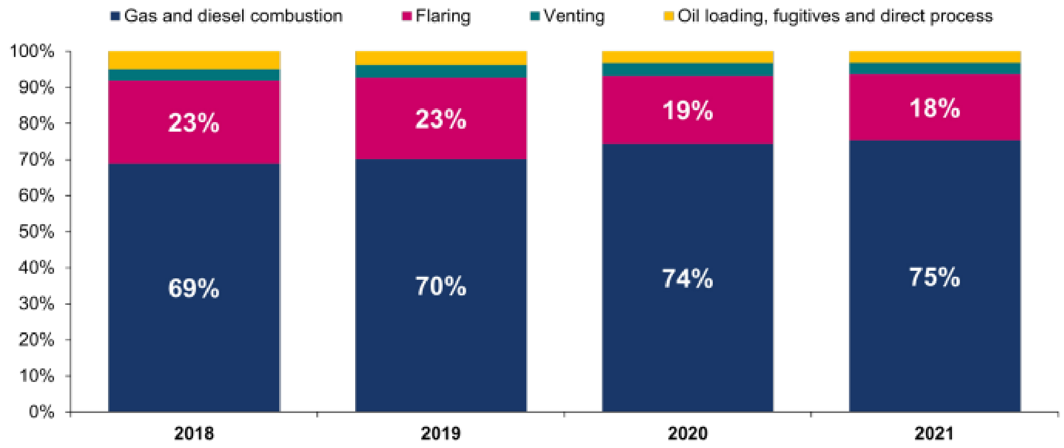
UKCS North Sea Challenge



Industry GHG Emissions by Source, 2021 (UK National Atmospheric Emissions Inventory, 2022)

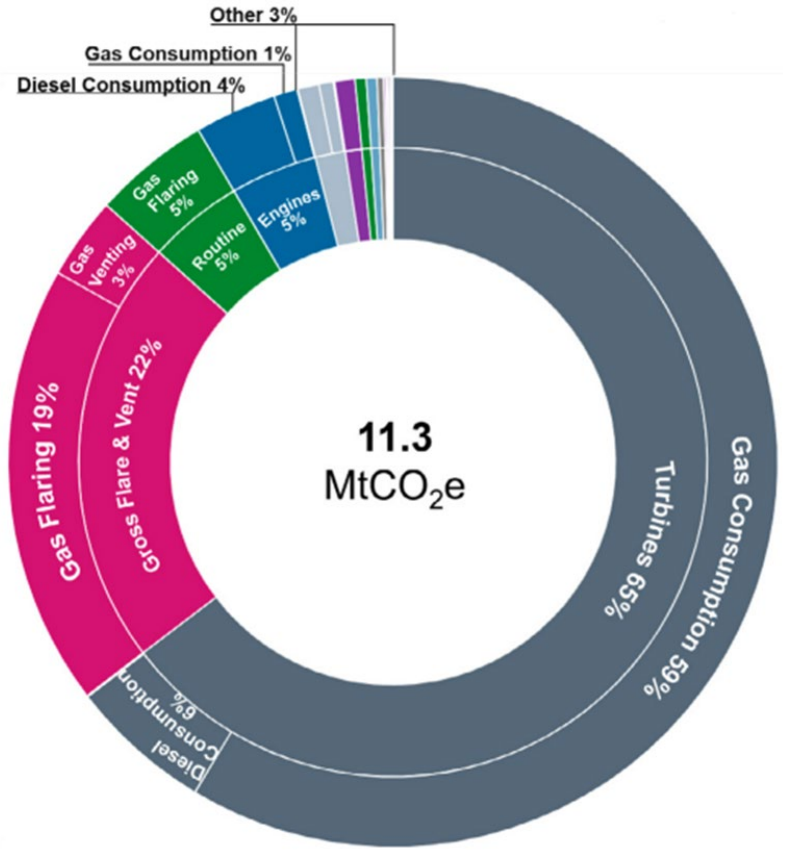


UK Upstream Oil and Gas Emissions by Gas, 1990 to 2021 (UK National Atmospheric Emissions Inventory, 2022)



Industry GHG emissions per source, 2018 to 2021 (UK National Atmospheric Emissions Inventory, 2022)

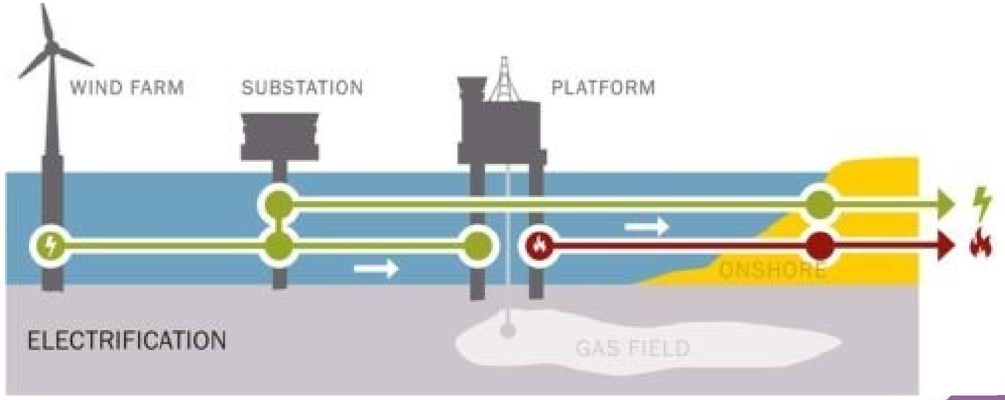
North Sea Emissions Reduction Strategies



Facility Emissions by Source and Category in 2021
(North Sea Transition Authority, 2022)

Options to reduce source emissions:

- **Power generation:** Use renewables such as **wind**, solar, hydrogen and hydroelectric.
- **Methane:** Eliminate routine flaring and mitigate methane leaks
- **Subsea technologies**: Subsea power distribution, compression, pumping and oil storage.
- **Carbon capture, and storage projects.**



Platform Electrification
(Centre of Expertise Water & Energy, 2018)

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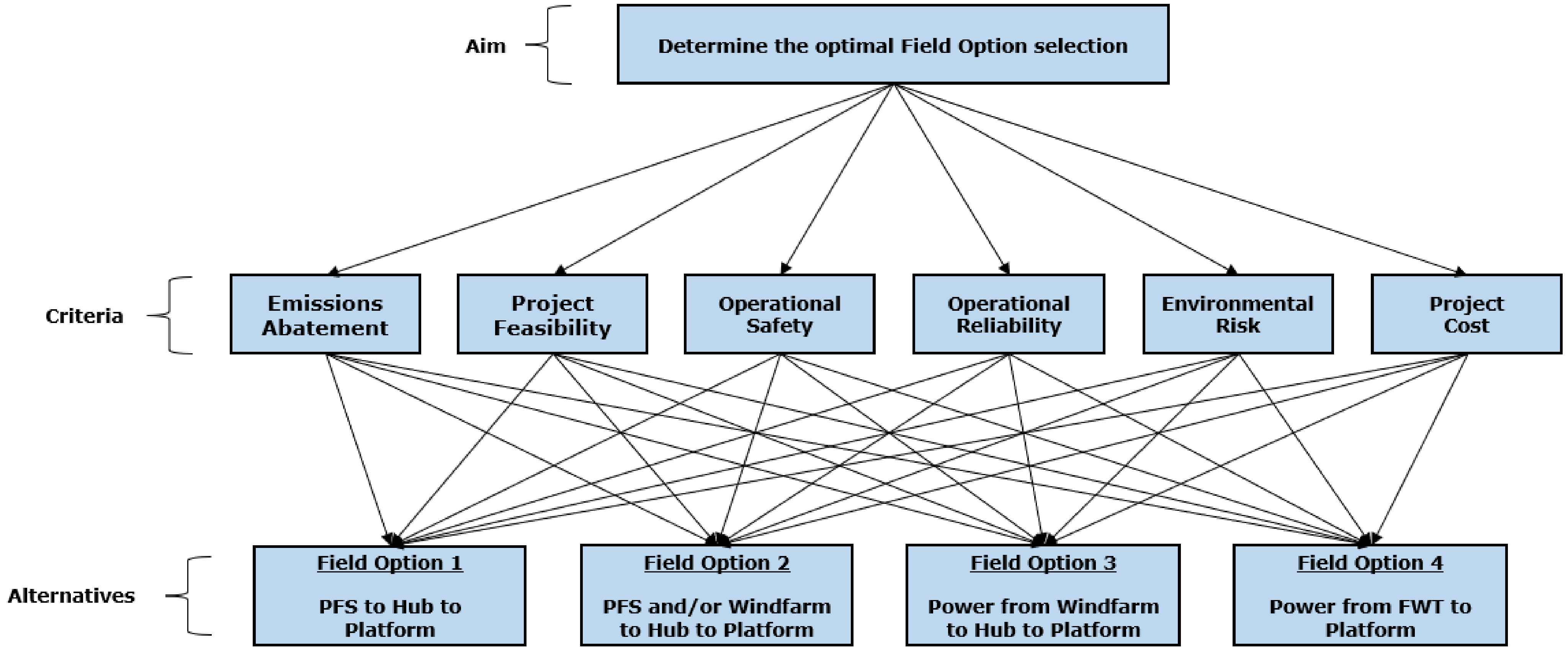
Decarbonisation Option: Platform Electrification

- Can significantly reduce offshore emissions in the North Sea by an estimated **10 MT CO_2e**, which equates to 70% of total offshore emissions or 10% or the total UK energy sector.
- Notional concepts set out by the NSTA:
  1. Power from shore – HVDC transmission to hub; hub substation
  2. Power from a wind farm – offshore windfarm; HVDC transmission to/from shore
  3. Power from an offshore microgrid – dedicated windfarm; hub with back-up power generation capacity and battery storage
  4. Standalone solutions – wind turbines(s) to platform; back-up power generation capacity.

Analytical Hierarchy Process (AHP)



AHP Methodological Approach

- **Criteria Weighting**

Criteria	Level 1 Weights	Level 2 Weights
Technical Analysis	**0.5**	
Emissions Abatement		0.2
Project Feasibility		0.2
Operational Safety		0.2
Operational Reliability		0.2
Environmental Risk		0.2
Economic Analysis	**0.5**	
Project Costs		1

- **Criteria Categories**

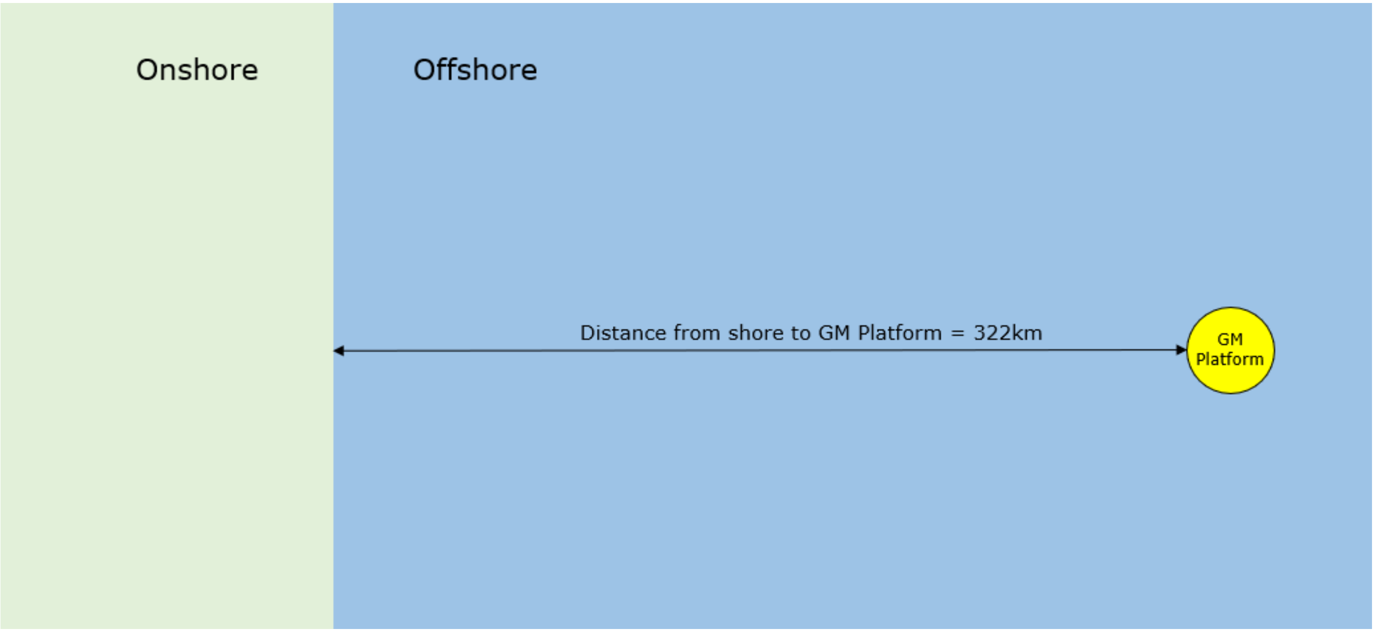
Score	Category
100	Best
80	Excellent
60	Good
40	Fair
20	Poor
0	Worst

- **Criteria Scoring:**
  - Technical Score = (0.2 x Score) + (0.2 x Score) + (0.2 x Score) + (0.2 x Score) + (0.2 x Score) x 0.5
  - Economic Score = (1 x Score) x 0.5
  - Combined Score = Technical Score + Economic Score

North Sea Case Study

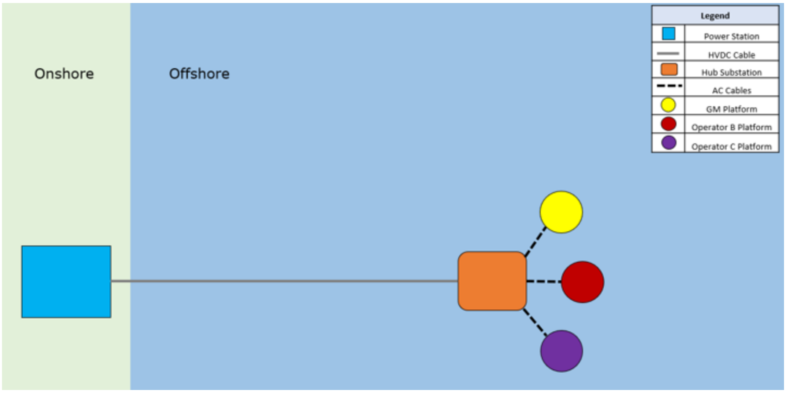
- Case study is an anonymous Operator / “GM” Platform
- Case study data:
    - GM platform 322 km from shore in the North Sea.
    - Cessation of Production is expected in 2040.
    - Power demand average on platform is 8 MW.
    - Emissions average on platform is 287 CO_2e/T.
    - Wind velocity average at field is 12.5 m/s.

Existing Field Layout

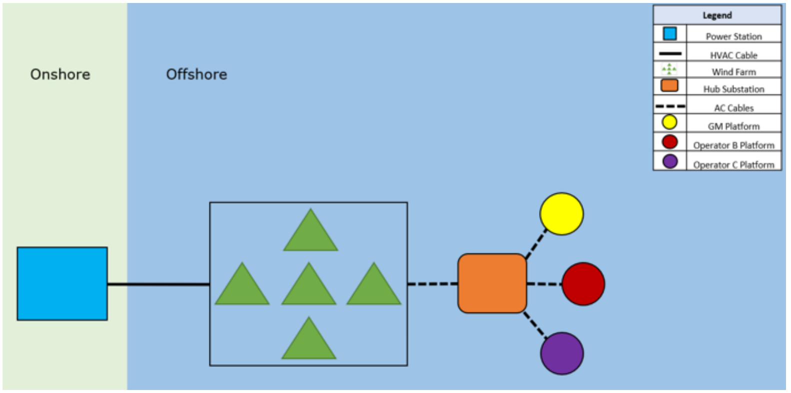


North Sea Case Study: Field Options

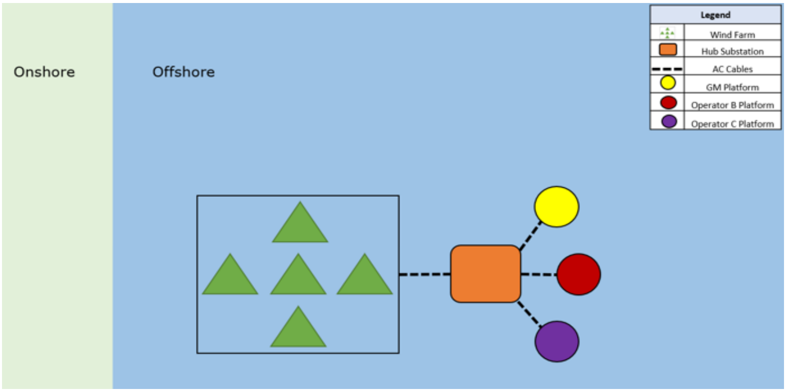
Field Option 1: PFS TO Hub to Platform



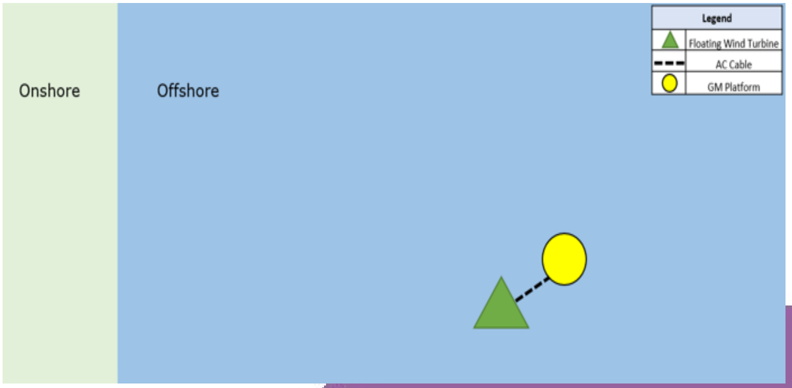
Field Option 2: PFS and/or Windfarm to Hub to Platform



Field Option 3: Power from windfarm to Hub to Platform

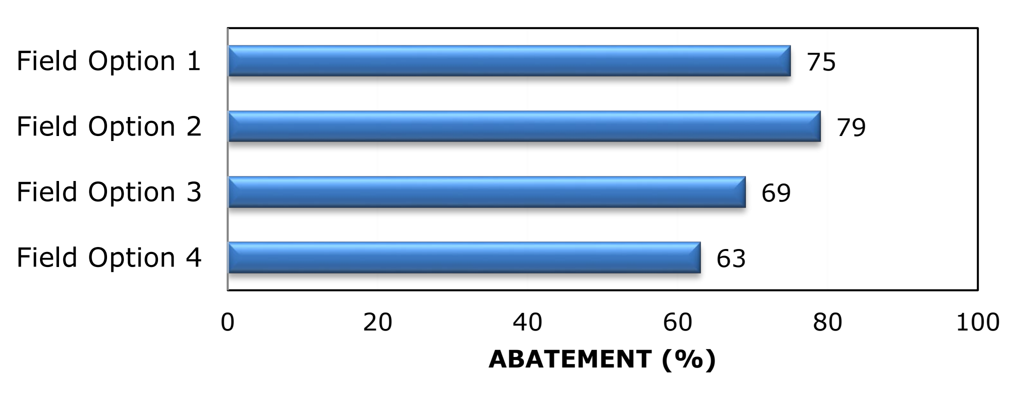


Field Option 4: Power from FWT to Platform



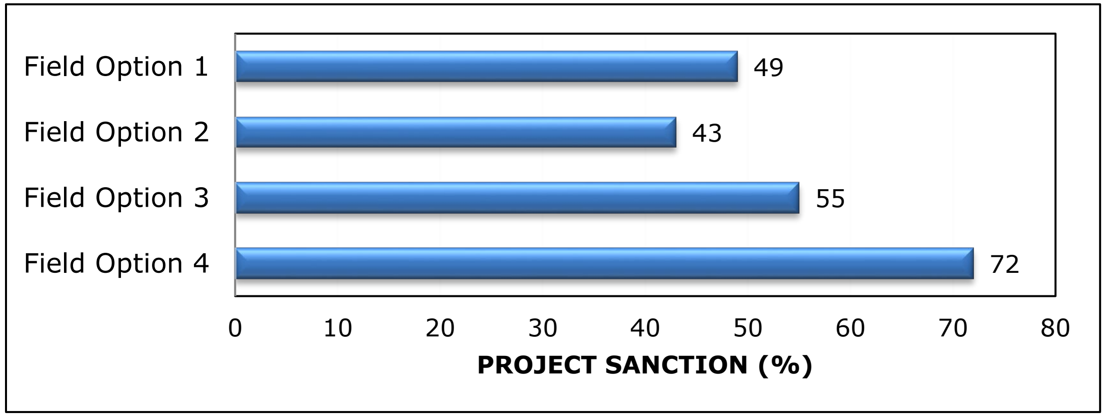
Technical Analysis

Emissions Abatement



Score	Category	Emissions Abatement (%)	Field Option
100	Best	Largest Reduction	2
80	Excellent	70 or more	1
60	Good	60-69	3
40	Fair	50-59	N/A
20	Poor	49 or less	N/A
0	Worst	Smallest Reduction	4

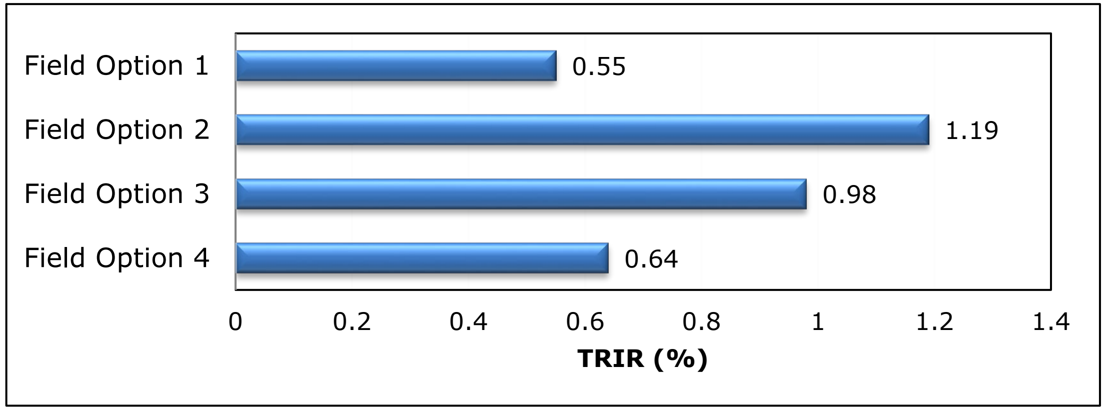
Project Feasibility



Score	Category	Project Feasibility (%)	Field Option
100	Best	Highest Opportunity of Project Sanction	4
80	Excellent	70 or more	N/A
60	Good	60-69	N/A
40	Fair	50-59	3
20	Poor	49 or less	1
0	Worst	Lowest Opportunity of Project Sanction	2

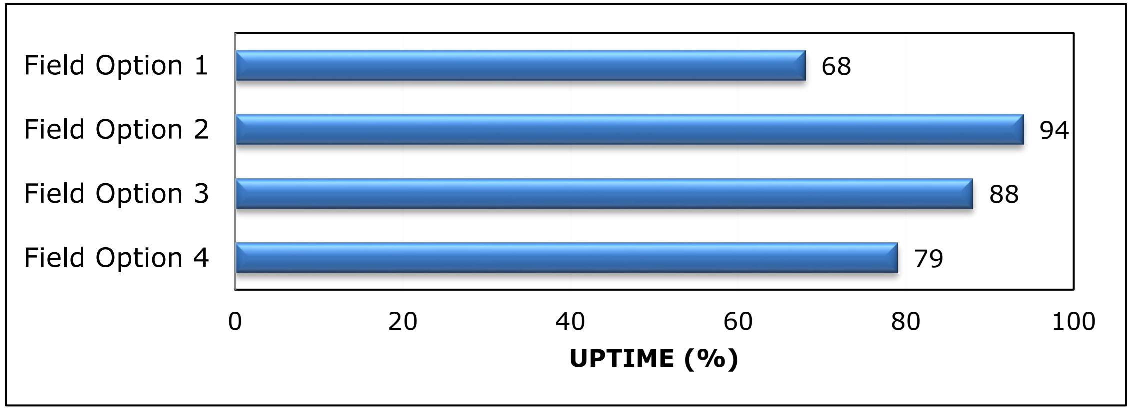
Technical Analysis

Operational Safety



Score	Category	Operational Safety (%)	Field Option
100	Best	Lowest Risk of Safety Incident	1
80	Excellent	0.6 or less	4
60	Good	0.61-1	3
40	Fair	1-1.09	N/A
20	Poor	1.1 or more	N/A
0	Worst	Highest Risk of Safety Incident	2

Operational Reliability



Score	Category	Operational Reliability (%)	Field Option
100	Best	Highest Uptime	2
80	Excellent	90 or more	N/A
60	Good	80-89	3
40	Fair	70-79	4
20	Poor	69 or less	N/A
0	Worst	Lowest Uptime	1

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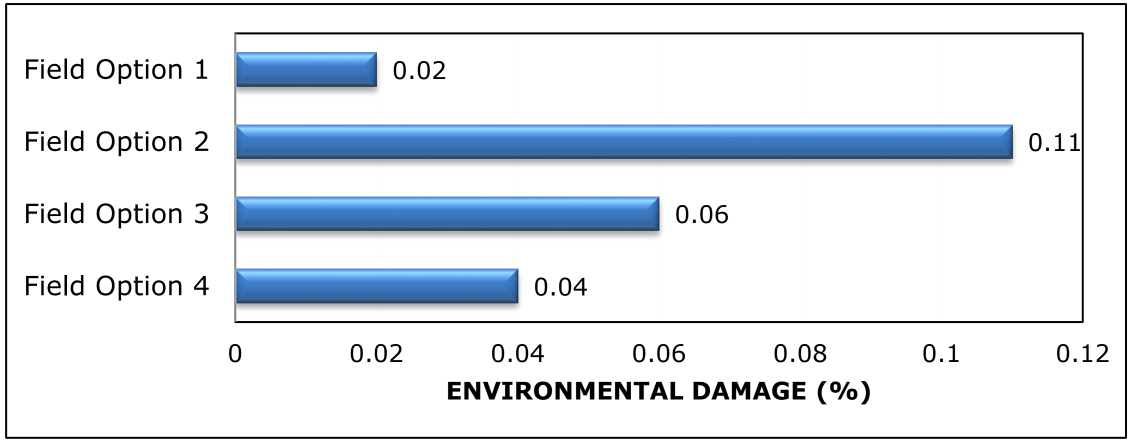
Technical Analysis

Environmental Risk



Score	Category	Environmental Risk (%)	Field Option
100	Best	Lowest Risk of Environmental Damage	1
80	Excellent	0.03 or less	N/A
60	Good	0.031-0.05	4
40	Fair	0.051-0.1	3
20	Poor	0.101 or more	N/A
0	Worst	Highest Risk of Environmental Damage	2

Final Technical Score

Criteria	Field Option 1	Field Option 2	Field Option 3	Field Option 4
Technical Analysis				
Emissions Abatement	80	100	60	0
Project Feasibility	20	0	40	100
Operational Safety	100	0	60	80
Operational Reliability	0	100	60	40
Environmental Risk	100	0	40	60
Technical Score	**30**	**20**	**26**	**28**
Ranking	**1**	**4**	**3**	**2**

Ranking 1st for Technical Score is Field Option 1

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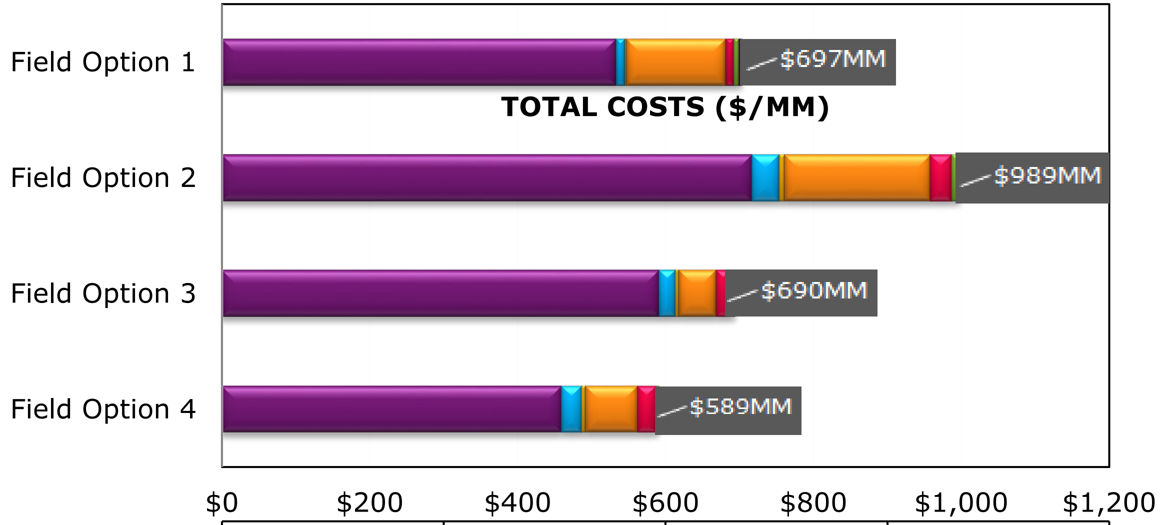
Economic Analysis

Project Costs Results



	Field Option 4	Field Option 3	Field Option 2	Field Option 1
CAPEX	$459	$591	$717	$533
Commissioning	$27	$22	$36	$12
Engineering	$6	$5	$8	$2
OPEX	$70	$50	$197	$134
Decommissioning	$25	$20	$29	$11
Licenses	$3	$4	$9	$7
Insurance	$1	$2	$2	$4
Emissions Saving	-$2	-$4	-$9	-$6

Score	Category	Project Cost ($/MM)	Field Option
100	Best	Lowest Cost	4
80	Excellent	$600 or less	3
60	Good	$601-$700	1
40	Fair	$701-$800	N/A
20	Poor	$801 or more	N/A
0	Worst	Highest Cost	2

Final Economic Score

Criteria	Field Option 1	Field Option 2	Field Option 3	Field Option 4
Economic Analysis				
Project Cost	60	0	80	100
Economic Score	**30**	**0**	**40**	**50**
Ranking	**3**	**4**	**2**	**1**

Ranking 1st for Economic Score is Field Option 4

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Combined Analysis

Final Combined Analysis

Criteria	Field Option 1	Field Option 2	Field Option 3	Field Option 4
Technical	30	20	26	28
Economic	30	0	40	50
Combined	**60**	**20**	**66**	**78**
Ranking	**3**	**4**	**2**	**1**

Ranking 1st for Combined Score is Field Option 4

Sensitivity Analysis Results (60% / 40%)

Criteria	Field Option 1	Field Option 2	Field Option 3	Field Option 4
Technical	36	24	31.2	33.6
Economic	24	0	32	40
Combined	**60**	**24**	**63.2**	**73.6**
Ranking	**3**	**4**	**2**	**1**

Sensitivity Analysis Results (40% / 60%)

Criteria	Field Option 1	Field Option 2	Field Option 3	Field Option 4
Technical	24	16	20.8	22.4
Economic	36	0	48	60
Combined	**60**	**16**	**68.8**	**82.4**
Ranking	**3**	**4**	**2**	**1**

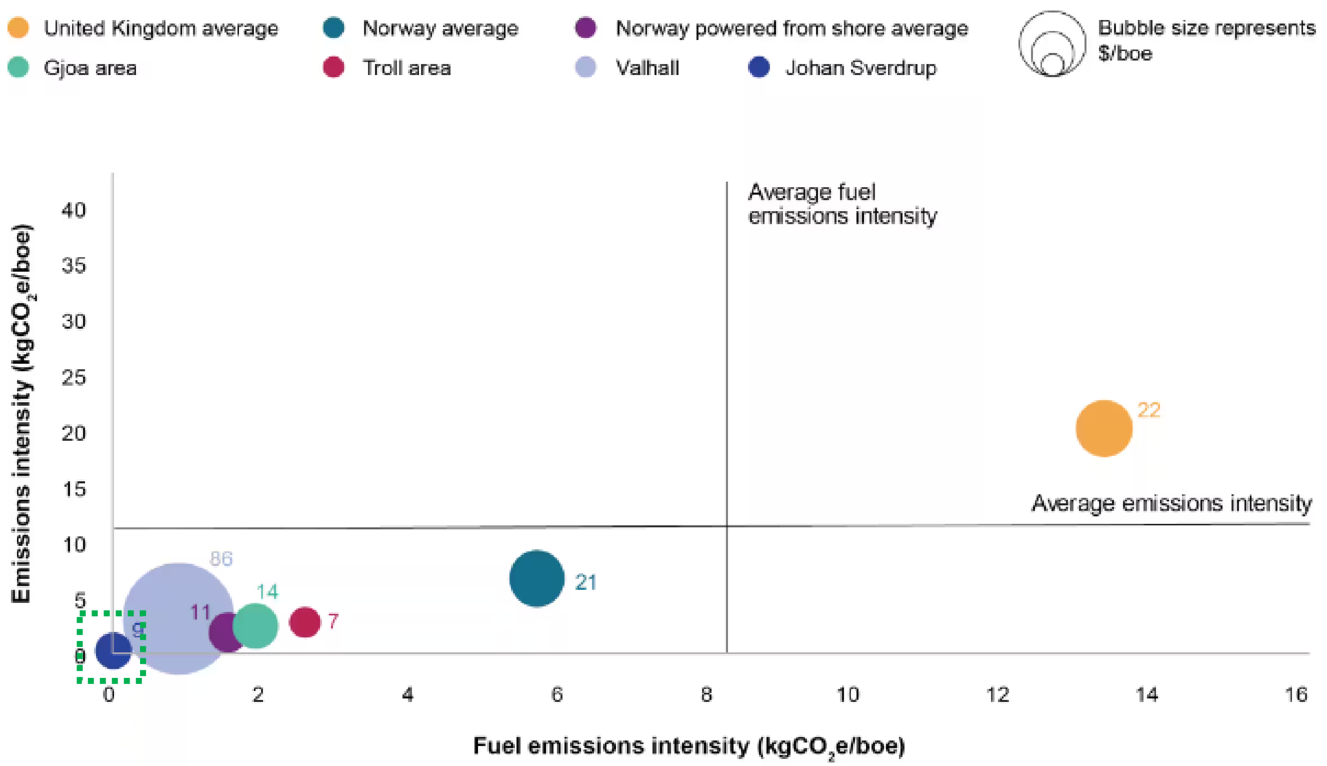
Conclusion

- Platform electrification can satisfy the Energy Trilemma for operators in the North Sea.
- Platform electrification Field Option 4 (Power from FWT to Platform) is the optimal emissions reduction strategy for the “GM” North Sea Case Study.
- Beyond Net Zero in 2050, integrated renewables systems will be required globally to reduce climate change effects.

“Performing while Transforming: Decarbonising UKCS Production”

- **Integration:** Synergies from smartly combining uses and technologies across and within classical and new energy sectors, to boost efficiency and economic viability.
- **Partnerships:** Collaboration and strategic planning is crucial in addressing climate change and developing sustainable oil and gas production assets while securing a sustainable future.

UKCS Pathway Forward



Data compiled Aug. 17, 2023.
Bubble sizes correspond to costs (dollars) per barrel of oil equivalent. Average and individual power from shore projects shown in the figure.
Source: S&P Global Commodity Insights upstream E&P content (Vantage).

Johan Sverdrup case study:

- Third largest oil field on the NCS.
- Production at 755,000 boe/d.
- 80 to 90% less carbon emissions compared to a standard development employing gas turbines.

Lessons learnt and translation on NCS success to UKCS:

- Power from shore.
- Carbon capture and storage.
- Ban on all routine flaring.
- Industry cooperation.

Thank you for listening!