Gaffney Cline

Carbon Intensity of the West Newton Field

Prepared for

Reabold Resources PLC and Union Jack Oil PLC

21 May 2024

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Approved by Gaffney, Cline & Associates Limited

Project Manager: ______________________ 21 May 2024

Basil Al-Shamma, Principal Advisor

Reviewed by: ______________________ 21 May 2024

Drew Powell, Principal Advisor

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Introduction

At the request of Reabold Resources PLC and Union Jack Oil PLC ("the Client"), Gaffney, Cline & Associates Limited (GaffneyCline) has performed a Carbon Intensity study for the West Newton field.

Reabold Resources PLC (Reabold) and Union Jack Oil PLC (UJO) are individually listed on the London Stock Exchange AIM market. Reabold currently holds an approximate 56% economic interest in PEDL 183 and the West Newton project, through a direct 16.665% license interest and a 59% shareholding in Rathlin Energy, the operator of the Joint Venture for PEDL 183 (and with equity of 66.67%). UJO holds a 16.665% interest in PEDL 183.

Reabold and UJO have requested a carbon intensity evaluation study from GaffneyCline for the West Newton field. The effective date of this analysis is 21st May 2024.

GaffneyCline is an international petroleum consultancy, which has been operating worldwide since 1962. GaffneyCline focuses solely on the petroleum and energy industry, and specializes in the provision of policy, strategy, technical and commercial assistance to governments, financial institutions, and national and international oil, gas and energy companies worldwide. The provision of Carbon Management Practice advisory services and Carbon Intensity Assessments are core components of GaffneyCline's international business.

This report relates specifically and solely to the subject matter as defined in the scope of work proposal as set out herein, and is conditional upon the specified assumptions. The report must be considered in its entirety and must only be used for the purpose for which it is intended.

A glossary of terms and abbreviations is included as Appendix I.

Basis of Opinion

This document reflects GaffneyCline's informed professional judgment based on accepted standards of professional investigation and, as applicable, the data and information provided by the Client, the limited scope of engagement, and the time permitted to conduct the evaluation.

In line with those accepted standards, this document does not in any way constitute or make a guarantee or prediction of results, and no warranty is implied or expressed that actual outcome will conform to the outcomes presented herein. GaffneyCline has not independently verified any information provided by, or at the direction of, the Client and has accepted the accuracy and completeness of this data. GaffneyCline has no reason to believe that any material facts have been withheld, but does not warrant that its inquiries have revealed all of the matters that a more extensive examination might otherwise disclose.

The opinions expressed herein are subject to and fully qualified by the generally accepted uncertainties associated with the interpretation of technical data and do not reflect the totality of circumstances, scenarios and information that could potentially affect decisions made by the report's recipients and/or actual results. The opinions and statements contained in this report are made in good faith and in the belief that such opinions and statements are representative of prevailing physical and economic circumstances.

GaffneyCline has not undertaken a site visit and inspection because it was not included in the scope of work. As such, GaffneyCline is not in a position to comment on the operations or facilities in place, their appropriateness and condition, or whether they are in compliance with the regulations pertaining to such operations. Further, GaffneyCline is not in a position to comment on any aspect of health, safety, or environment of such operation.

GaffneyCline has also not included the impact of any current or potential future carbon pricing scheme.

GaffneyCline is not in a position to attest to property title or rights, conditions of these rights (including environmental and abandonment obligations), or any necessary licenses and consents (including planning permission, financial interest relationships, or encumbrances thereon for any part of the appraised properties).

Qualifications

In performing this study, GaffneyCline is not aware that any conflict of interest has existed. As an independent consultancy, GaffneyCline is providing impartial technical, commercial, and strategic advice within the energy sector. GaffneyCline's remuneration was not in any way contingent on the contents of this report.

In the preparation of this document, GaffneyCline has maintained, and continues to maintain, a strict independent consultant-client relationship with "the Client". Furthermore, the management and employees of GaffneyCline have no interest in any of the assets evaluated or are related with the analysis performed, as part of this report.

Staff members who prepared this report hold appropriate professional and educational qualifications and have the necessary levels of experience and expertise to perform the work.

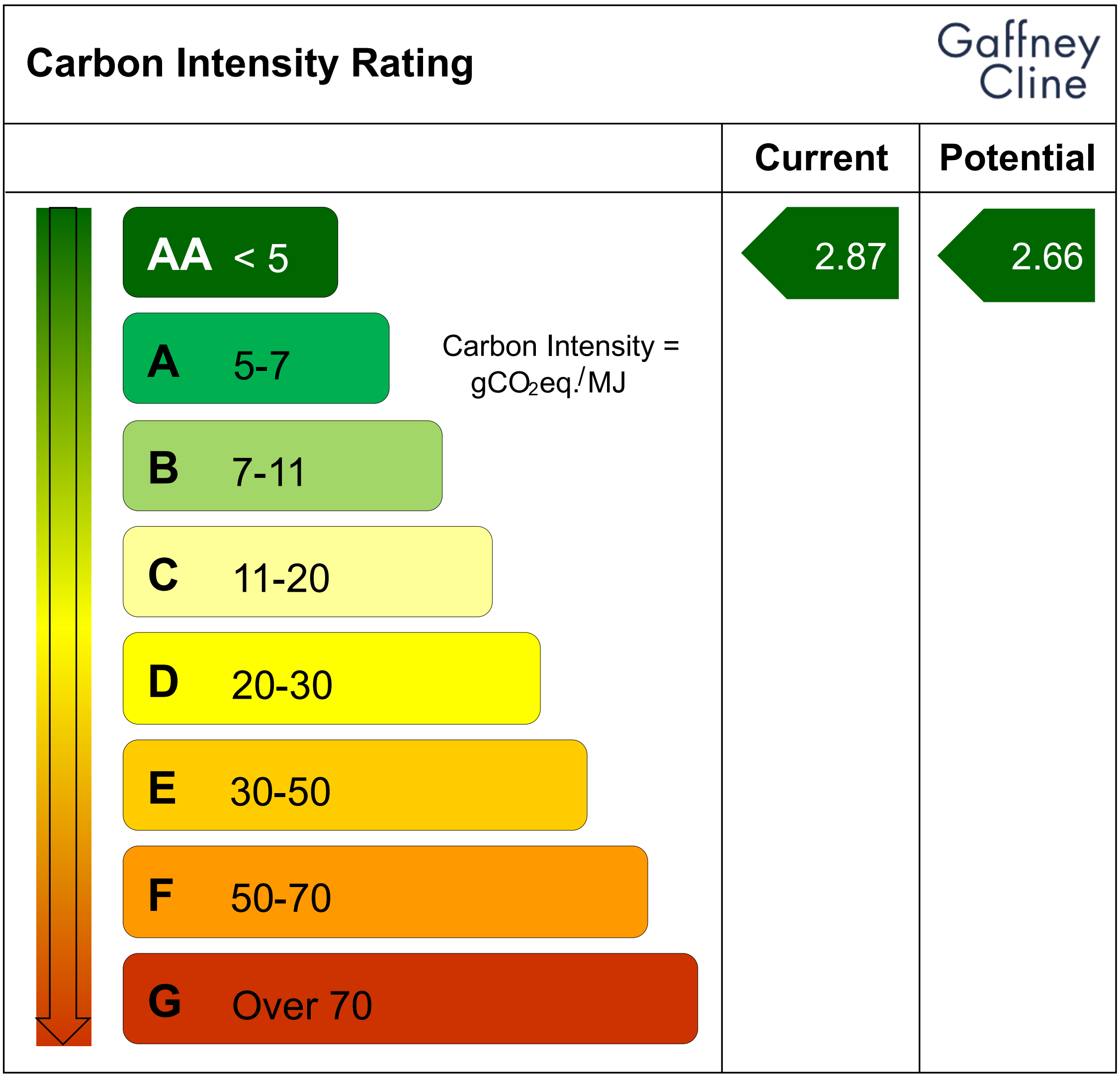
Executive Summary

The full field development plan focusses on a gas development with associated condensate.

The following conclusions can be drawn:

- The West Newton field has an AA rating for Carbon Intensity (see Figure 1);
- There is potential to improve the Carbon Intensity either by reducing fugitive, flaring and venting emissions further and by gas to grid development, reducing on site gas and condensate processing and using the shortest possible route to the National Grid.

Figure 1: Carbon Intensity Rating



The Carbon Intensity of the West Newton field was calculated using the Oil Production Greenhouse gas Emissions Estimator (OPGEE version 3.0b) with parameters selected from GaffneyCline's Global field database as well as specific West Newton parameters including the notional development plan and recovery mechanism. The Carbon Intensity of the West Newton field was benchmarked against other field analogues using the in-house Global field database.

In addition, the outcomes were analysed and insights provided on the major contributing factors to the overall Carbon Intensity of the field and which emission sources are the most cost effective to reduce.

The Base Case in addition to several sensitivity cases were considered as shown in Table 1.

Table 1: Summary of Base Case and Sensitivities/Results

Case	Description	Carbon Intensity ($gC0_2Eq/MJ$)
Base Case	Maximum field gas rate 42 MMscfd, CGR =2.9 stb/MMscf OPGEE Gas to the grid, condensate trucked, no water. Minimum Gas Processing: Dehydrator.	2.87
Sensitivity 1	OPGEE Gas to the grid, condensate trucked, no water. Gas Processing: None	2.66
Sensitivity 2	OPGEE Gas to the grid, condensate trucked, no water. Gas Processing: Dehydrator + Amine Process + Demethanizer	4.01
Sensitivity 3	OPGEE Gas to the grid via existing 3rd party facilities in the area, condensate trucked, no water. Gas Processing: Dehydrator + Amine Process + Demethanizer,	4.11
Low Case	Maximum field gas rate 30 MMscfd, CGR =2.9 stb/MMscf OPGEE Gas to the grid, condensate trucked, no water. Gas Processing: Dehydrator + Amine Process + Demethanizer	4.19

Figure 1 shows the Global Carbon Intensity Rating system GaffneyCline have developed. West Newton has an AA rating based on the Global Dataset.

The following recommendations are given:

- The most cost-effective sources of emissions that can be readily managed are likely to be Fugitive, Flaring and Venting.
- These emissions can be effectively managed within Conceptual and Front-End Engineering Design (FEED), by the development of fit for purpose procurement specifications such as tight leak-rate specifications and in the development of targeted commissioning and operations philosophies as well as detailed plans.
- On location processing of gas and condensate with minimum processing requirements subject to National Grid gas specification.
- Shortest connection point to the National Grid.
- An update of the Carbon Intensity study is recommended once the project is more advanced with a final field development plan.

Discussion

1 Methodology

For the Carbon Intensity evaluation GaffneyCline used a tool called the Oil Production Greenhouse gas Emissions Estimator (OPGEE), developed at Stanford University with support from GaffneyCline. This tool is used, amongst other applications, by the California Air Resources Board for regulation of transport fuel related Green House Gas (GHG) emissions.

The OPGEE tool selects parameters from a range of 'smart' defaults, however these are not always optimal for specific fields.

GaffneyCline is then able to harness appropriate parameters available from their proprietary Global database of Carbon Intensity evaluations for over 9,000 oil and gas fields, categorized with metadata for analogue field identification, and a classification system for recovery mechanism.

The following detailed approach was taken to the study of the West Newton field:

1. GaffneyCline determined the key input parameters and assumptions based on client provided information and by analysing the parameters from the Carbon Intensity database for analogous fields. The data required included the following:
    a. Specific West Newton reservoir and fluid parameters;
    b. Recovery mechanism;
    c. Notional Development Plan;
    d. Analysis of analogues from the database; and
    e. Discussion internally regarding the most suitable analogues and also adaptations of plant design parameters to reflect the high standards expected by the UK regulatory authorities.
2. The OPGEE tool was then used to calculate the Carbon Intensity of the West Newton field using the data identified above in step 1.
3. The Carbon Intensity of the West Newton field was then benchmarked against other field analogues in the UK and rated using the GaffneyCline Carbon Intensity Rating system for Global and Regional datasets.
4. Insights were provided on the major contributing factors to the overall Carbon Intensity and which emission sources are the most cost effective to manage downwards.

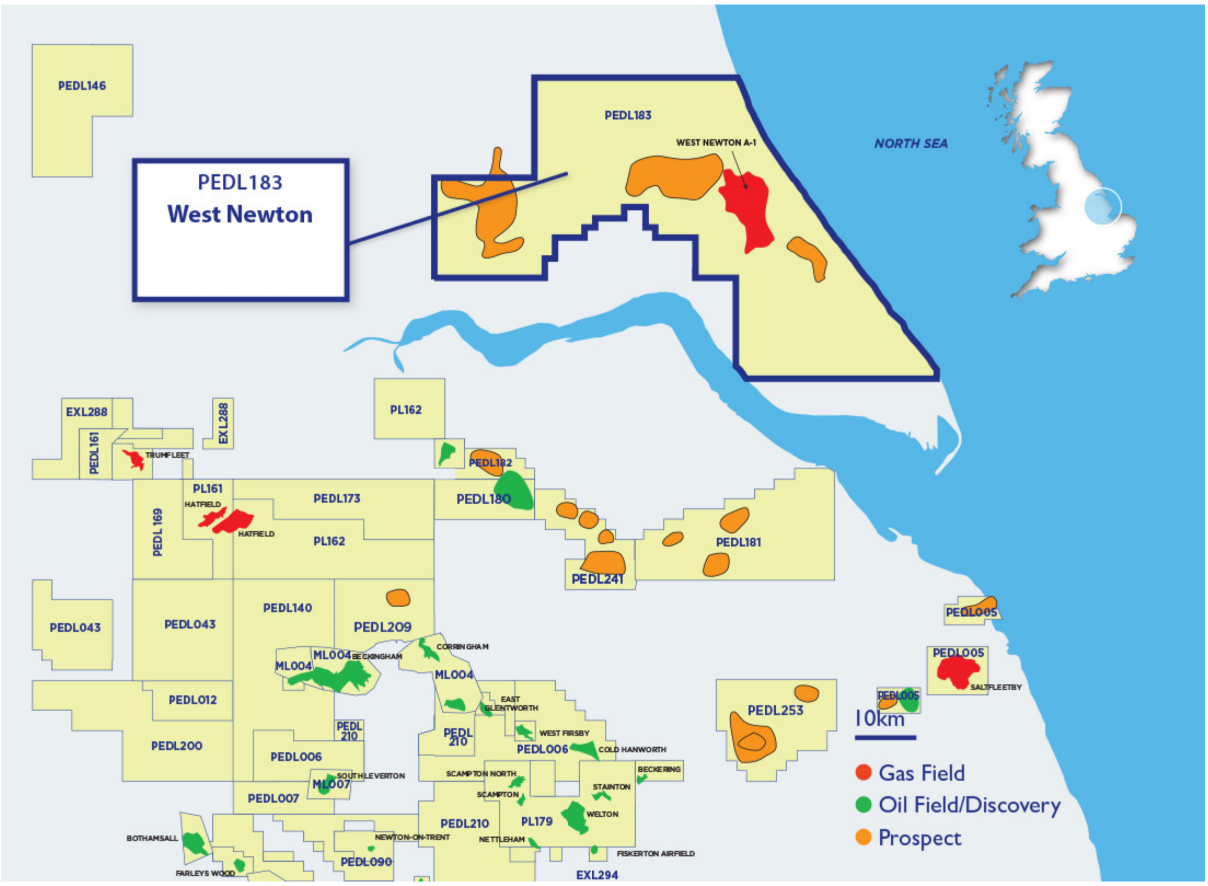
2 Description of Field Development Plan and Surrounding Key Infrastructure

The West Newton Kirkham Abbey Shoal accumulation was discovered by the West Newton A-1 (2013-2014) well, which encountered an over-pressured Kirkham Abby Shoal. Several gas samples were collected on this well, however, a production test was not successful. A second well West Newton A-2 (2019) was drilled with good gas shows through the entire Kirkham Abbey section. West Newton B-1 and sidetrack B-1Z were drilled in 2020.

A Competent Person's Report (CPR) by RPS Energy was provided to GaffneyCline which concluded, based on the Petroleum Management Resource System (PRMS) requirements, that the discovered accumulation is currently categorized as Contingent Resources - development pending.

Figure 2 shows the West Newton field (Kirkham Abbey Shoal Discovery), PEDL 183.

Figure 2: The West Newton Opportunity in PEDL183



Source: UJO

The development plan is provided in the CPR and is described further in section 2.1.

2.1 Field Development Plan: Base Case

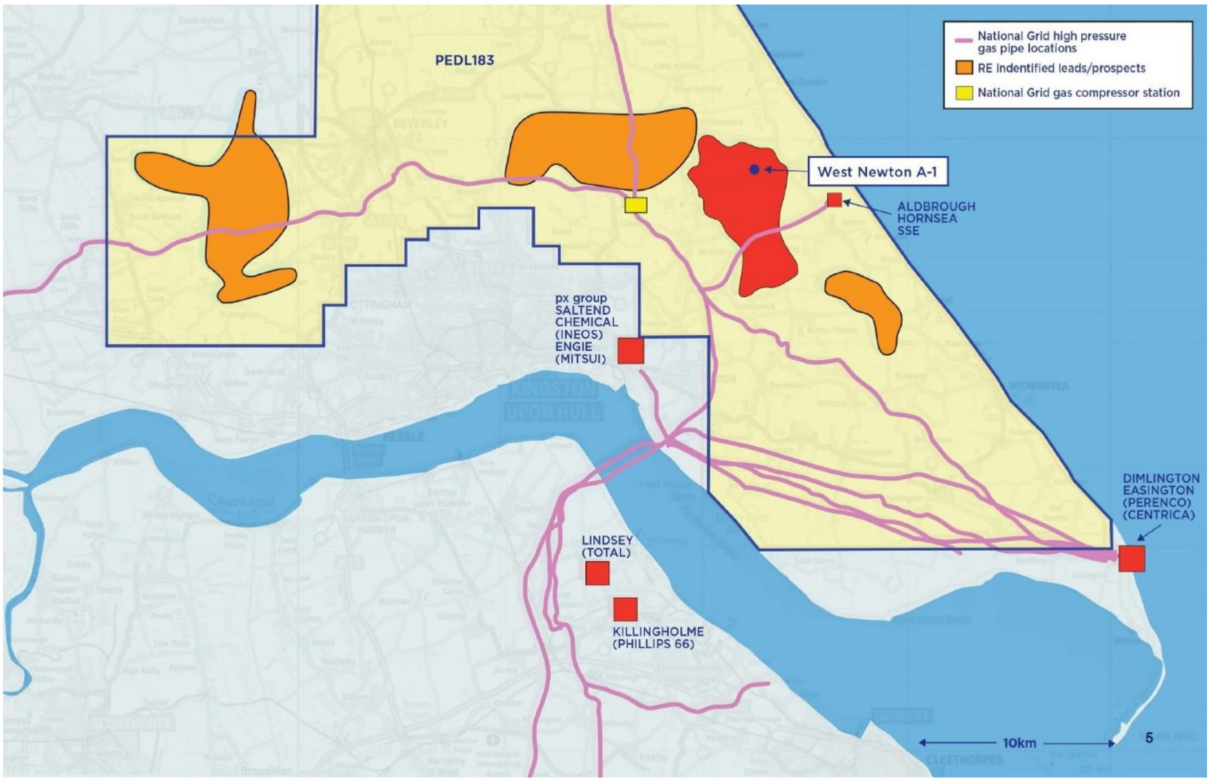
- Gas field with condensate (CGR =2.9 stb/MMscf);
- 10 horizontal wells;
- Gas production processed on location (at Kirkham Abbey wells) and transported to the grid via pipeline, and condensate is trucked.
- Inter-field pipeline to the closest National Transmission System (NTS) site (3.5 km);

2.2 Local Infrastructure

PEDL183 (and the West Newton field) is well connected to major infrastructure (see Figure 3).

The field development plan assumes all gas production is commercialised by supply into the highly fungible, traded NBP market, via either the high or regional pressure pipeline systems in the UK. The West Newton project lies within a very short distance (closest ~3.5 km) from several existing sections of the high-pressure NTS. The National Grid (NG) requires certain gas specifications for all gas presented for delivery into the NTS. According to the CPR, current indications based on PVT sample analysis from West Newton, reveal that gas recovered comes very close to NG specifications and could be delivered to NG with minimum treatment.

Figure 3: Proximity to Markets and Infrastructure



Source: UJO

Following extended well testing, if gas treatment does prove to be required, the following options are considered:

- On site processing;
- Delivery as raw gas to the Saltend Combined Cycle Gas Turbine (CCGT) facility (approx.11.3 km).

Another option would be transportation to existing treatment facilities. Two major gas terminals are also located nearby, namely:

- Dimlington (Perenco operated); and
- Easington (Centrica operated).

These will provide a UK National Grid connection if offsite processing is required.

3 Base Case and Sensitivities

Given the early phase of the project and uncertainties, a number of sensitivities in terms of project parameters and options, have been examined (see Table 2).

The Base Case assumes the field development plan of 10 horizontal wells with a maximum field gas production of 42 MMscfd and 2.9 stb/MMscf condensate gas ratio (CGR) and no water production. The Base case also assumes minimum gas processing and local tie-in to grid. The condensate is also exported by truck.

Sensitivity, 1 assumes the same as the Base Case, but with no gas processing, to represent the case that the existing gas composition meets the NG specifications.

Sensitivity 2 is the same as the Base Case but with onsite gas processing comprising Dehydrator, Amine Process and Demethanizer.

Sensitivity 3 assumes the same as the Base Case but with a pipeline to an external 3rd party processing facility such as Dimlington or Easington for processing, before connecting to the NG.

A Low Case was also produced to simulate maximum field gas production of 30 MMscfd and 2.9 stb/MMscf CGR with the same gas processing requirements as Sensitivity 2.

Table 2: Description of Base Case, Sensitivities and Low Case

Case	Description
Base Case	Maximum field gas rate 42 MMscfd, CGR =2.9 stb/MMscf, no water. OPGEE Gas to the grid, condensate trucked, no water. Minimum Gas Processing: Dehydrator.
Sensitivity 1	OPGEE Gas to the grid, condensate trucked, no water. Gas Processing: None
Sensitivity 2	OPGEE Gas to the grid, condensate trucked, no water. Gas Processing: Dehydrator + Amine Process + Demethanizer
Sensitivity 3	OPGEE Gas to the grid via existing external 3rd party facilities in the area, condensate trucked, no water. Gas Processing: Dehydrator + Amine Process + Demethanizer,
Low Case	Maximum field gas rate 30 MMscfd, CGR =2.9 stb/MMscf OPGEE Gas to the grid, condensate trucked, no water. Gas Processing: Dehydrator + Amine Process + Demethanizer

3.1 Parameters with Significant Uncertainty

A parameter that is currently very uncertain and not defined in the CPR, but which has significant impact on the outcome of the Carbon Intensity calculation, is the gas processing requirements to meet the gas specification required for the National Grid (NG).

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4 Key Assumptions Used

The following key assumptions for OPGEE inputs were used after a client kick-off meeting. Please note that after the client meeting, a decision has been made to use zero Water Gas Ratio (WGR) (see Table 3).

Table 3: List of OPGEE Inputs

Input Data Required	Data Provided by/ Agreed with Client		Notes
Field Depth	1,750 m		
End of field life proposed	30 years		From first gas.
Gas production volume	Maximum Gas Production = 48 MMscfd		Kirkham Abby wells = 10 MMscfd per well.
Number of producing wells	10 wells		As per capacity of existing well pads.
Reservoir Pressure	3,150 psia at 1,750 m reservoir depth		Top of reservoir no higher than this but may be deeper. Gas is over-pressurized by 27%.
Reservoir Temperature	55°C		
API Gravity (Deg)	41		From original sample.
Gas Composition	Component	% Mol	from well WN A-1
	N2	**2.84**	
	H2S	**0.00**	
	CO_2	**0.64**	
	C1	**90.32**	
	C2	**4.39**	
	C3	**1.07**	
	C4i	**0.15**	
	C4n	**0.28**	
	C5i	**0.10**	
	C5n	**0.09**	
	C6	**0.08**	
	C7	**0.03**	
	C8	**0.01**	
	C9	**0.00**	
	C10+	**0.00**	
	TOTAL	**100**	
Condensate to Gas Ratio	This is a gas and condensate field with a low CGR =2.9 stb/MMscf		

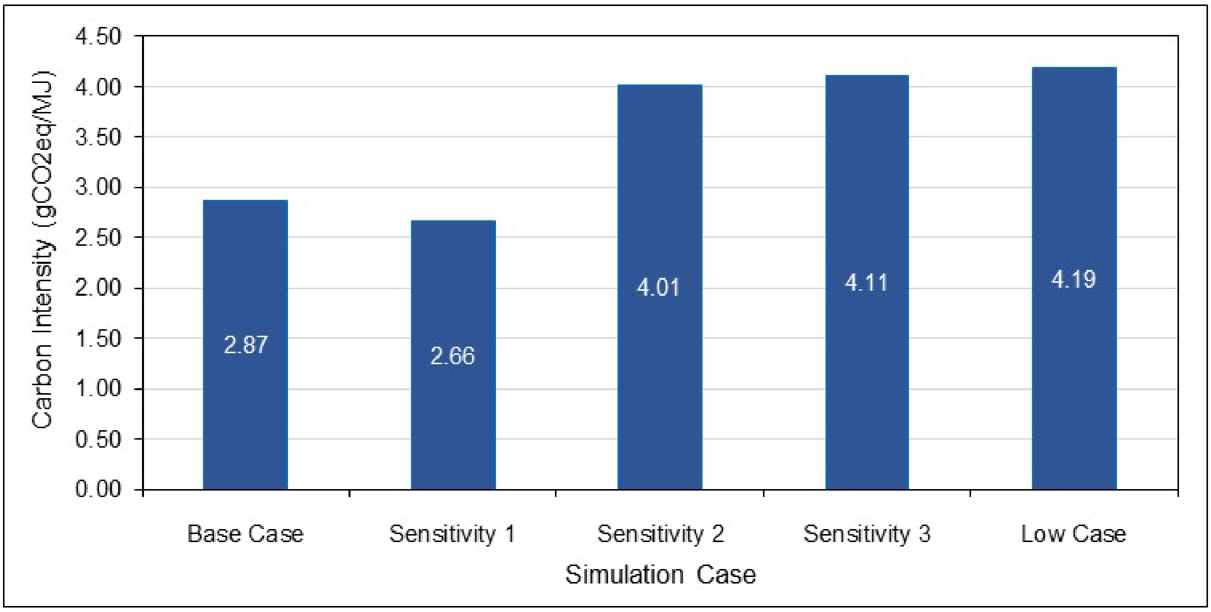
Input Data Required	Data Provided by/ Agreed with Client	Notes
Water to Gas Ratio	No water	
Recovery mechanism	Natural depletion	
Transport of condensate	Pipeline gas to National Grid and condensate to be trucked	There will be restrictions to the maximum numbers of truck movements based on UK planning rules.
Gas and Condensate Processing	Minimum Gas processing (Dehydration)	Gas Composition very close to NG specification according to CPR.
Use of Gas	Gas pipeline to National Grid	
Conceptual well design	Kirkham Abbey – all horizontal 4.5” production tubing.	
Flaring	In line with North Sea Transition Authority (NSTA) requirements, 10 days of flaring per year due to process upsets assumed.	No continuous flaring.

5 Results and Analysis/Benchmarking Against Other Facilities

5.1 Results

Figure 4 shows the Results of the OPGEE assessment of Carbon Intensity for the West Newton field Base Case, sensitivities Cases and Low Case.

Figure 4: West Newton Field OPGEE Results



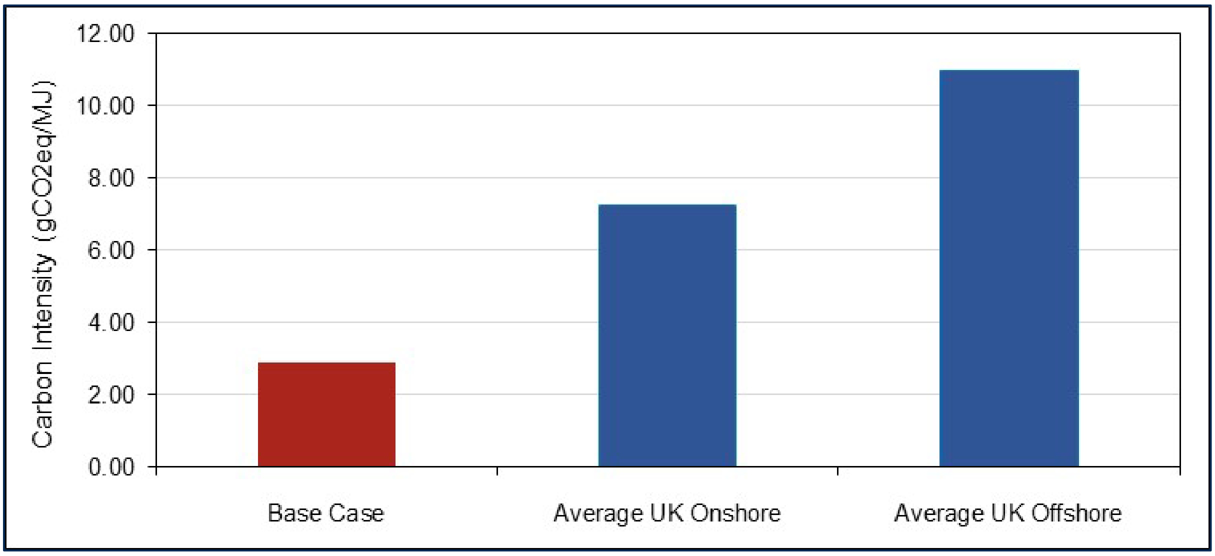
5.2 Benchmarking

The West Newton field Base Case result has been compared to a selection of UK Onshore and Offshore field analogues and also benchmarked against 'All UK Fields'. See Figures 5 and 6.

The West Newton Carbon Intensity Base Case has also been compared to imported Liquefied Natural Gas (LNG) from the NSTA Natural Carbon Footprint analysis[1] published in July 2023 and also shown in Figure 6.

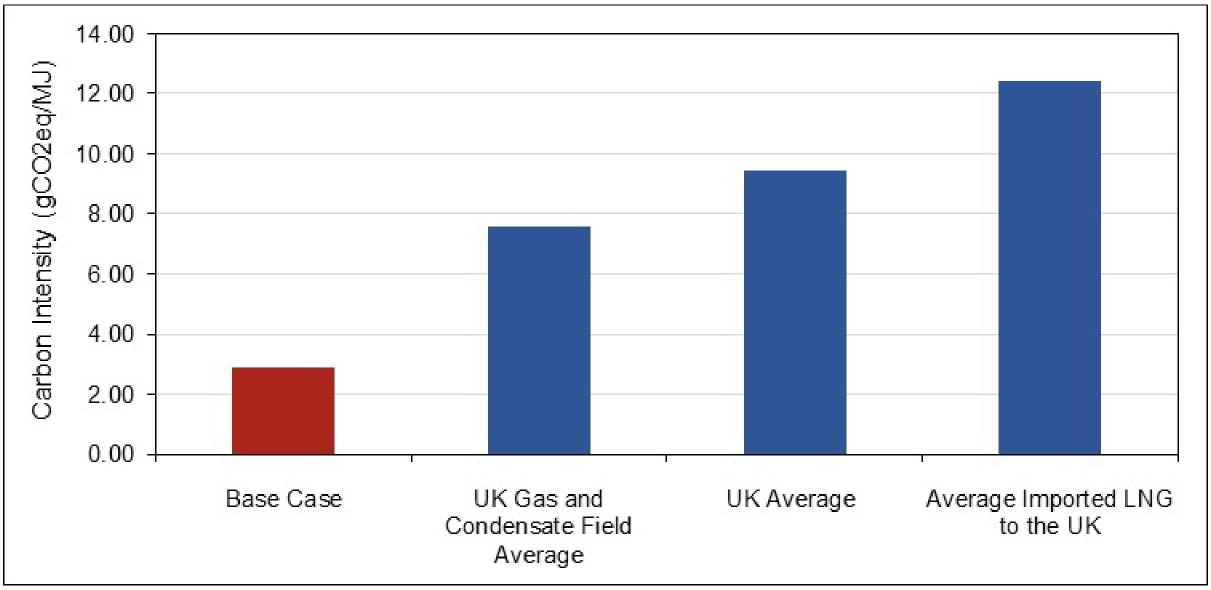
[1] https://www.nstauthority.co.uk/the-move-to-net-zero/net-zero-benchmarking-and-analysis/natural-gas-carbon-footprint-analysis/

Figure 5: West Newton Field Carbon Intensity versus UK Onshore and Offshore Field Analogues



Note: Average UK onshore and offshore fields include oil and gas fields.

Figure 6: West Newton Field Carbon Intensity versus All UK Fields & UK Gas and Condensate Fields



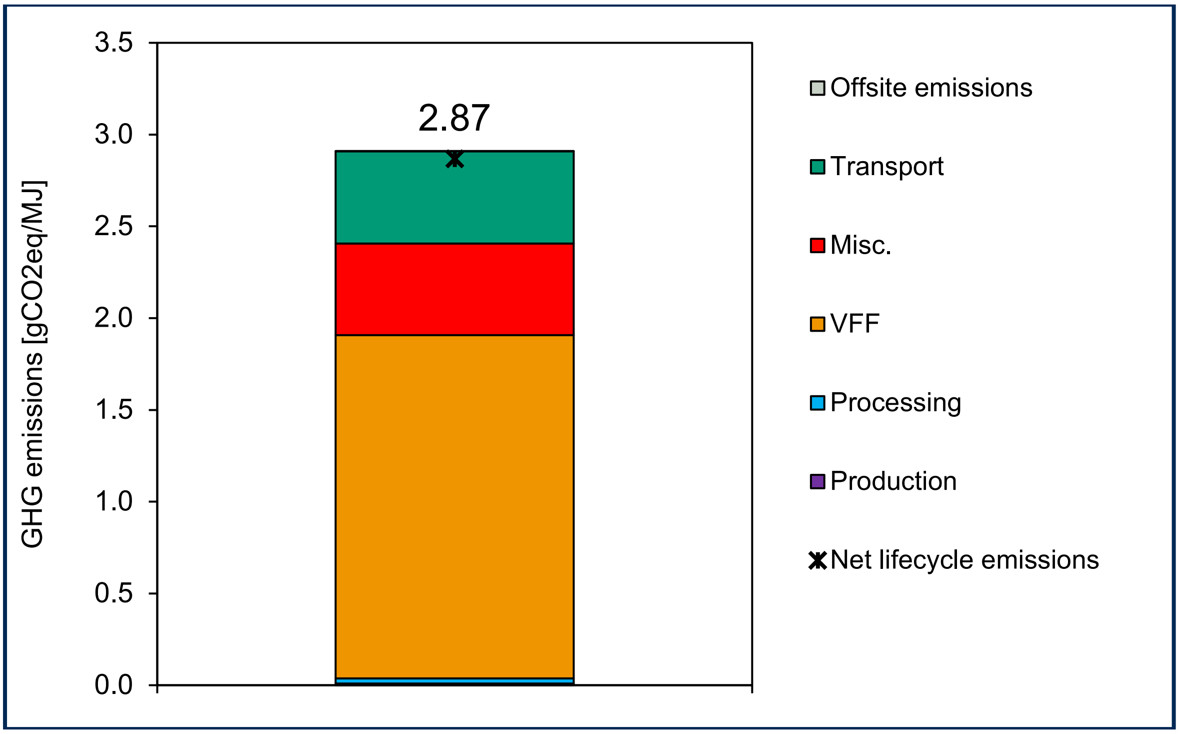
Notes:

1. Average UK includes oil and gas fields and are predomenantly offshore fields.
2. The average imported LNG Carbon Intensity (NSTA 2022).

5.3 Analysis of Results

Figure 7 shows the main contributors to the Base Case Carbon intensity of 2.87 gCO_2eq/MJ. The biggest contributors are Venting, Flaring and Fugitive (VFF) emissions followed by transport emissions.

Figure 7: Main Contributors to West Newton Field (Base Case) Carbon Intensity (CI)



The West Newton field has a Carbon Intensity significantly lower than the UK average and also when compared to onshore and offshore analogues. It is also significantly lower than average imported LNG, based on the NSTA Natural Carbon Footprint Analysis published in July 2023. However, there is still some potential to improve the Carbon Intensity by concentrating on reducing VFF emissions using the techniques described in Section 6 and by minimizing process facilities for the gas and condensate treatment, and with use of on-location facilities, and also with use of a shorter route to the National Grid.

6 Improvement Opportunities

6.1 General

Current research suggests that carbon emissions from petroleum production can be quite variable. Facilities will tend to have low carbon emissions per unit of energy produced if they do not rely on energy intensive production methods and apply effective controls to fugitive emissions sources.

For West Newton the most cost-effective sources of emissions that can be managed are likely to be Venting Fugitives and Flaring (VFF). These can be handled within Conceptual and Front-End Engineering Design (FEED), by the development of fit for purpose procurement specifications and in the development of targeted commissioning and operations philosophies and detailed plans. In addition, the distance to process facilities can be minimized by processing gas on location, in which case the distance to the National Grid inlet would be much shorter.

6.1.1 VFF Emissions

Flaring and venting are a major source of carbon emissions from oil and gas fields. The main relevant UK regulatory authorities are the Environmental Agency (EA) and the North Sea Transition Authority (NSTA). In England, usually the respective County Council is also responsible for managing the planning process as the strategic planning authority. These bodies all have high expectations in terms of carbon emission management and reduction. [NB – Nationally Significant Infrastructure Projects (NSIP) will fall under the central government Development Consent Order (DCO) process, but it is unlikely that the first phase of this project will meet that threshold].

The NSTA is the regulator for flaring and venting under the Energy Act 1976 (and as amended by the Energy Act 2016 and the Petroleum Act 1998.) Consents are required for the flaring and venting of hydrocarbons during production operations. Operators are required to demonstrate that all reasonable steps have been taken to keep flaring and venting during operations to a minimum.

6.1.2 Reduction of Gas Flaring/Venting

A commitment to zero flaring except for emergencies, process upsets and for necessary maintenance is likely to be expected by the regulatory authorities and this is included as a base input to OPGEE. Please note that some flaring may be allowed during activities such as extended well tests, but this has not been included in the current OPGEE calculation.

6.1.3 Specific Examples

Within Engineering Design and Procurement, the following aspects should be considered:

Best Available Technology Not Entailing Excessive Costs (BATNEEC) studies can take place either during the conceptual engineering design phase or more usually at Front End Engineering (FEED) depending on the pace of the permit and consent process versus the engineering design process.

- Vapour Recovery system, which avoids local maintenance venting by connecting all process vessels to the flare system.
- Use Nitrogen as a blanketing gas for storage tanks rather than natural gas.
- Use of inert gases for pilot and (where required purge gas).
- All gas flared rather than vented for emergency blowdown.
- A reliability and maintenance study to ensure that sufficient redundancy is in the system.
- Use of dual fuel generators (natural gas and diesel).
- Zero-Bleed Valves.
- Consider heat integration projects if appropriate.

Within Commissioning Philosophy, following aspects should be considered:

- A well thought out commissioning and post-commissioning test programme to determine practical plant limits and hence avoid process upsets and hence flaring.
- A high quality well clean-up programme to avoid contaminants getting into the system, causing process upsets, and hence flaring.

Within Operations Philosophy, following aspects should be considered:

- A Systematic Programme for reducing fugitive emissions using leak detection and repair technologies (LDAR) to tackle Venting, Flaring and Fugitive emissions.

Appendix I
Glossary

GLOSSARY
Standard Oil Industry Terms and Abbreviations

AIM	Alternative Investment Market
BATNEEC	Best Available Technology Not Entailing Excessive Costs
Bbl	Barrels
/Bbl	Per barrel
BECCS	Bio-energy with carbon capture and storage
BHP	Bottom hole pressure
blpd	Barrels of liquid per day
Bscf or Bcf	Billion standard cubic feet
Bscfd or Bcfd	Billion standard cubic feet per day
°C	Degrees Celsius
CAPEX	Capital expenditure
CCGT	Combined Cycle Gas Turbine
CI	Carbon Intensity
CGR	Condensate to gas ratio
CO_2	Carbon dioxide
CO_{2e}	Carbon Dioxide Equivalent
CPR	Competent Persons Report
DCO	Development Consent Order
EA	Environment Agency
EOR	Enhanced Oil Recovery
FDP	Field Development plan
FFD	Full Field Development
FEED	Front end engineering and design
ft	Foot/feet
gCO_2Eq/MJ	Grams of Carbon Dioxide Equivalent per Megajoule
GC	GaffneyCline
GHG	Green House Gases
GOC	Gas oil contact
GOR	Gas oil ratio
GWP	Global Warming Potential
HSE	Health, Safety and Environment
J	Joule (Metric measurement of energy; 1 kilojoule = 0.9478 BTU)
LDAR	Leak Detection and Repair
n/a	Not applicable
N_2	Nitrogen
NG	National Grid
NSIP	Nationally Significant Infrastructure Projects
NSTA	North Sea Transition Authority
NTS	National Transmission System
OPEX	Operating expenditure
OPGEE	Oil Production Greenhouse gas Emissions Estimator
OWC	Oil water contact
PEDL	Petroleum Exploration and Development Licence
psia	Pounds per square inch absolute
psig	Pounds per square inch gauge
PVT	Pressure volume temperature
scf	Standard cubic feet
ST	Side track
TD	Total depth
WGR	Water Gas Ratio