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Evaluating Net Cash Flow in Greenfield Oil and Gas Projects: A Case Study of Low, Base, and High Scenarios

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ABSTRACT

This study conducts a comprehensive net cash flow (NCF) analysis of a greenfield oil and gas project, utilizing secondary data to evaluate low, base, and high case scenarios. The field, expected to produce oil for 19 years (2020-2039), has estimated recoverable reserves of 1,086 million barrels (MMbbl). In the base case scenario, the project yields an NCF of $27,748,650, with significant cost components including water variable costs at $3/bbl, oil variable costs at $7/bbl, and an oil price of $50/bbl. Sensitivity analysis via a tornado diagram reveals oil price as the most influential variable, with fluctuations significantly impacting NCF. The low case scenario results in an NCF of $9,815,950, driven by lower oil prices and reduced costs, while the high case scenario projects an NCF of $45,681,350 under favorable economic conditions. The project's financial performance transitions from negative NCF during initial high-cost phases (2020-2023) to positive NCF from 2024 onwards, peaking in oil production years (2024-2029) and subsequently declining due to reduced reservoir pressure. These findings underscore the critical role of oil price and operational efficiency in the financial viability of greenfield oil projects, providing strategic insights for future investments and operational planning.

Keywords: *Net cash flow, greenfield project, oil and gas, sensitivity analysis.*

1. Introduction

The petroleum industry is a crucial component of the global economy, serving as a foundation for various sectors and influencing geopolitical dynamics worldwide (Fanchi & Christiansen, 2017; Mazeel, 2010; Peterson, 2009). Greenfield oil and gas projects, which involve developing new fields on previously undeveloped land, are essential in the energy sector's efforts to meet growing global demand (Feineman, 2009; Gonzalez et al., 2019; Ma, 2020; Nesvold & Bratvold, 2023; Ortiz-Volcan et al., 2018; Sinha et al., 2024). These projects demand substantial initial investments and carry significant risks due to volatile oil prices and high exploration, drilling, and production costs (Mian, 2015; Thapar, 2024). Understanding the financial viability of these projects is crucial for stakeholders, including investors, operators, and policymakers, who must navigate these uncertainties to make informed decisions (Mian, 2015; Thapar, 2024).

Net cash flow (NCF) analysis is a fundamental tool in assessing the economic feasibility of oil and gas projects (Bo et al., 2023; Ferro et al., 2012; Kuuskraa et al., 1977; Lima & Suslick, 2002; Merklein et al., 1972; Mian, 2020; Nascimento et al., 2018; Paidin et al., 2010; Parti- et al., 1979; Stanley, 1982; Thompson, 1998). By projecting cash inflows and outflows over the life of a project, NCF analysis helps determine potential profitability and financial sustainability. Previous studies have underscored the importance of NCF analysis, yet there remains a need for a comprehensive examination tailored to greenfield projects, considering their unique challenges and uncertainties. This study addresses this gap by conducting an in-depth NCF analysis of a greenfield oil and gas project, examining low, base, and high case scenarios to provide a nuanced understanding of the project's financial performance under varying economic conditions (Mian, 2015; Thapar, 2024).

The objective of this research is to assess the financial viability of a greenfield oil and gas project by conducting a comprehensive NCF analysis, comparing financial outcomes across different economic scenarios (low, base, and high), and identifying critical factors such as oil prices and operational efficiency that influence the financial success of these projects.

The findings of this study contribute to a deeper understanding of the economic challenges and opportunities in greenfield oil and gas development. The insights gained are intended to guide future investments, operational planning, and risk management strategies, ultimately supporting more informed decision-making in the energy sector.

2. Literature Review

The petroleum industry is characterized by its complexity, with factors such as fluctuating oil prices, geopolitical tensions, and technological advancements influencing decision-making processes (Mazeel, 2010; Merklein et al., 1972; Mian, 2015;

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Peterson, 2009; Sundberg, 1980). As a pillar of the global economy, the petroleum industry drives economic growth and development across various sectors. Effective management of financial resources is central to the success of petroleum exploration and production projects (Mian, 2015; Thapar, 2024).

This literature review critically analyzes the significance of net cash flow (NCF) analysis in petroleum economics, particularly focusing on its application in greenfield projects throughout their life cycle. Previous studies have underscored the importance of NCF analysis, yet a detailed examination of its specific application to greenfield projects reveals gaps in the existing literature.

Net cash flow analysis involves projecting cash inflows and outflows over the life of a project to determine its potential profitability and financial sustainability. This method is widely recognized for its theoretical foundations and practical benefits. For instance, Merklein et al. (1972) and Kuuskraa et al. (1977) highlighted the role of NCF analysis in mitigating financial risks in petroleum projects. Lima and Suslick (2002) and Mian (2020) further elaborated on its utility in forecasting economic outcomes under varying market conditions.

However, while these studies provide valuable insights, they often focus on general applications without specifically addressing the unique challenges of greenfield projects. Greenfield projects, which involve the development of new fields on previously undeveloped land, present distinct financial uncertainties and operational risks that require tailored analytical approaches. Bo et al. (2023) and Nascimento et al. (2018) have touched upon these aspects, but a comprehensive evaluation remains lacking.

This study seeks to bridge this gap by conducting an in-depth NCF analysis of greenfield oil and gas projects. By examining low, base, and high case scenarios, this research aims to provide a nuanced understanding of the financial performance of greenfield projects under varying economic conditions. The findings will be compared with previous studies to highlight the specific financial challenges and opportunities unique to greenfield developments.

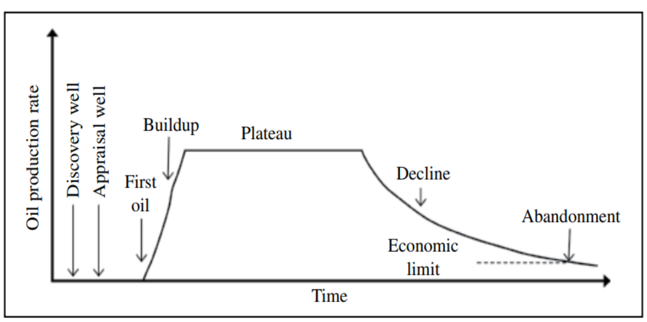

Figure 1. Typical production profile in petroleum industry (Fanchi & Christiansen, 2017)

This literature review emphasizes the critical role of NCF analysis in petroleum economics and underscores the need for specialized studies focusing on greenfield projects. By offering a detailed examination of NCF across different scenarios, this research contributes to a deeper understanding of the economic viability and financial management strategies essential for the success of greenfield oil and gas projects.

2.1. Petroleum Greenfield

The term *petroleum greenfield* typically refers to a new, undeveloped site or project for petroleum exploration, extraction, or refining (Ma, 2020; Sinha et al., 2024). It's a term commonly used in the oil and gas industry to describe a location where there has been little to no previous petroleum infrastructure or operations. *Greenfield* contrasts with *brownfield,* which refers to sites that have been previously developed or used for industrial purposes (Feineman, 2009; Gonzalez et al., 2019; Ma, 2020; Nesvold & Bratvold, 2023; Ortiz-Volcan et al., 2018; Sinha et al., 2024).

In essence, a petroleum greenfield represents a fresh opportunity for companies in the petroleum sector to establish new facilities or operations, often involving significant investment in infrastructure, technology, and human resources. These projects can involve exploration for new oil and gas reserves, the construction of new refineries, or the development of new processing facilities (Feineman, 2009; Gonzalez et al., 2019; Ma, 2020; Nesvold & Bratvold, 2023; Ortiz-Volcan et al., 2018; Sinha et al., 2024).

2.2. Importance of Net Cash Flow Analysis

The petroleum industry plays a pivotal role in global energy markets and economies, with exploration and production activities driving significant investments and revenue generation (Mian, 2015). Within this context, NCF analysis emerges as a critical tool in Petroleum Economics, providing stakeholders with essential insights into the financial performance and viability of projects (Mian, 2015; Thapar, 2024).

Net cash flow analysis involves the systematic examination of cash inflows and outflows associated with petroleum projects (Iledare & Fubara, 2017). It provides stakeholders with crucial insights into the financial health of projects, allowing for informed decision-making regarding investment, project development, and operational management (Iledare & Fubara, 2017; Mian, 2015; Thapar, 2024). By evaluating the timing and magnitude of cash flows, net cash flow analysis enables operators to assess project profitability, liquidity, and financial risk.

Cash flow model can be defined as the cycle of cash receipts (inward flow of cash) and cash disbursement (outflow of cash) that moves in or out of the treasury in a capital investment project (Iledare & Fubara, 2017). Cash flow is one of the commonly used profit models to evaluate the profitability of a capital investment project. The other models are the financial profit model and the tax profit model. The cash flow is usually preferred for economic analysis because it employs a discounted cash flow concepts that takes into cognizance the timing of cash flows and the economic opportunity cost (Iledare & Fubara, 2017). NCF is simply revenue (cash receipts) less expenditure (capital disbursement) during a period usually one year and

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projected over the economic project life (Iledare & Fubara, 2017; Mian, 2015; Thapar, 2024). Mathematically; NCF = net annual revenue – net annual expenditures.

a. A basic cash flow takes a production estimate and applies price to calculate a revenue stream.
Gross revenue = (Production Volume) x (Price) (1)

b. From this revenue stream, we subtract royalties to achieve net revenue
Net Revenue = (Gross Revenue) – (Royalties) (2)

c. From this revenue stream, we subtract operating expenses to achieve an Operating Income.
Operating Income = (Net Revenue) – (Operating Cost) (3)

d. Capital is then removed to create a BTCF.
BTCF = (Operating Income) – (Capital) (4)

e. Income taxes are then calculated.
Taxable Income = (Operating Income) – (Depreciation)
Taxes Payable = (Taxable Income) – (Tax Rate %) (5)

f. And the ATCF is created.
ATCF = (BTCF) – (Taxes Payable) (6)

Where:
NCF = *Net Cash Flow*
BTCF = *Before Tax Cash Flow*
ATCF = *After Tax Cash Flow*

Revenue is the amount of money earned by a firm from its regular business activities (Iledare & Fubara, 2017). Gross revenue is the proceeds from the sale of hydrocarbon which is interpreted as total volume of hydrocarbon produced multiply by the price of crude oil (Iledare & Fubara, 2017; Mian, 2015; Thapar, 2024). Royalty is a fiscal cost set by the legislation of the host government. it is usually a fraction of the gross revenue (Mian, 2015; Thapar, 2024). The CAPEX referred as a front-end cost is the money expended on the assets that will generate benefits for more than one year. It is either tangible or intangible (Mian, 2015; Thapar, 2024). The tangible CAPEX is capitalized and depreciated while the intangible CAPEX is expensed through amortization for tax calculation purposes. The operating expenditures are direct cost associated with production or injection. It consists of either fixed or variable OPEX (Iledare & Fubara, 2017; Mian, 2015; Thapar, 2024).

2.2.1. Guiding Investment Decisions

Net cash flow analysis guides investment decisions by helping stakeholders assess the financial viability of exploration and production projects (Kuuskraa et al., 1977; Merklein et al., 1972; Nascimento et al., 2018; Parti- et al., 1979; Stanley, 1982; Thompson, 1998). By analyzing projected cash flows over the project's life cycle, operators can evaluate the potential returns and risks associated with different investment opportunities. This allows for the allocation of capital to projects with the highest expected net present value and profitability (Mian, 2015; Thapar, 2024).

2.2.2. Optimizing Project Economics

Effective net cash flow analysis is essential for optimizing project economics and maximizing returns (Bo et al., 2023; Ferro et al., 2012; Lima & Suslick, 2002; Mian, 2020; Paidin et al., 2010). By identifying sources of cash inflows and outflows, stakeholders can implement strategies to enhance project profitability and mitigate financial risks (Mian, 2015; Thapar, 2024). This may include cost optimization measures, revenue enhancement initiatives, and risk management strategies tailored to the specific characteristics of each project (Mian, 2015; Thapar, 2024).

2.2.3. Ensuring Financial Sustainability

Net cash flow analysis plays a crucial role in ensuring the financial sustainability of petroleum projects (Ferro et al., 2012; Lima & Suslick, 2002; Mian, 2020). By assessing cash flow adequacy and liquidity, stakeholders can identify potential financial challenges and take proactive measures to address them (Parti- et al., 1979; Stanley, 1982; Thompson, 1998). This may involve securing financing arrangements, implementing cost-saving measures, or adjusting project development plans to maintain positive cash flow throughout the project life cycle (Mian, 2015; Thapar, 2024).

2.2.4. Navigating Market Volatility

In the face of volatile oil prices and market uncertainties, NCF analysis provides operators with the financial foresight necessary to navigate challenges and capitalize on opportunities (Kuuskraa et al., 1977; Lima & Suslick, 2002; Parti- et al., 1979; Stanley, 1982; Thompson, 1998). By conducting scenario analyses and sensitivity assessments, stakeholders can assess the impact of market fluctuations on project economics and adjust their strategies accordingly (Lucchesi, 2019).

2.3. Financial Management Strategies

Effective financial management is paramount in optimizing net cash flow and maximizing returns in petroleum projects. Strategies such as cost control, revenue optimization, and risk management are essential for maintaining positive cash flow and ensuring project sustainability (Mazeel, 2010; Peterson, 2009). In Green Field projects, where uncertainties are inherent, prudent financial practices are particularly crucial (Feineman, 2009; Gonzalez et al., 2019; Ma, 2020; Nesvold & Bratvold, 2023; Ortiz-Volcan et al., 2018). Operators must carefully allocate capital, manage project costs, and hedge against market risks to mitigate financial volatility and achieve long-term profitability.

2.4. Challenges and Opportunities in Greenfield Projects

Greenfield projects represent both challenges and opportunities throughout their life cycle (Feineman, 2009; Gonzalez et al., 2019; Ma, 2020; Nesvold & Bratvold, 2023;

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Ortiz-Volcan et al., 2018; Sinha et al., 2024). The initial exploration phase involves substantial capital investment and high geological risk as operators seek to identify and delineate hydrocarbon reserves (Mian, 2015; Thapar, 2024). As projects progress to the development and production phases, additional challenges emerge, including technical complexities, regulatory hurdles, and environmental considerations. Despite these challenges, Greenfield projects offer significant opportunities for value creation, particularly in regions with underexplored resources and favorable operating conditions (Feineman, 2009; Gonzalez et al., 2019; Ma, 2020; Nesvold & Bratvold, 2023; Ortiz-Volcan et al., 2018; Sinha et al., 2024).

2.5. Decision-Making and Optimization Strategies

Informed decision-making is critical for optimizing net cash flow and ensuring project success in Greenfield environments (Feineman, 2009; Fleckenstein & Zimmermann, 2013; Gonzalez et al., 2019; Ma, 2020; Nesvold & Bratvold, 2023; Ortiz-Volcan et al., 2018; Sinha et al., 2024). Decision-makers must conduct thorough economic evaluations, considering factors such as reserve potential, project economics, and market dynamics (Mian, 2015; Thapar, 2024). Furthermore, optimization strategies such as portfolio management, scenario analysis, and real options valuation can help operators identify the most value-enhancing development options and mitigate investment risks (Mazeel, 2010; Mian, 2015; Peterson, 2009; Stanley, 1982; Thapar, 2024). By leveraging net cash flow analysis and adopting robust decision-making frameworks, operators can maximize project value and achieve sustainable growth in Greenfield projects (Mazeel, 2010; Mian, 2015; Peterson, 2009; Stanley, 1982; Thapar, 2024).

3. Research Method

In this study, the research methodology is systematically outlined to ensure clarity in data collection, analysis, and interpretation. The research begins with an initial prediction, considered the first step in evaluating the project's economic viability. Data is gathered from reservoir engineers to estimate annual oil production based on changes in reservoir flow over time. Oil price assumptions are then made by analyzing market trends, historical data, and past experiences (Mian, 2015; Thapar, 2024). The methodology overview is as follows:

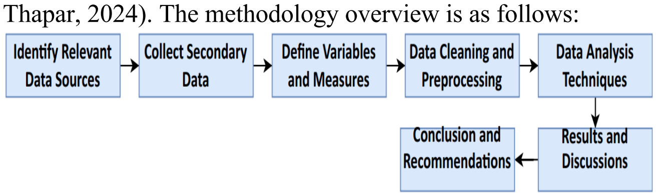

Figure 2. Methodology of the research

(a). Identify Relevant Data Sources**:** Identify secondary data sources that provide information on petroleum economics, particularly related to net cash flow analysis and greenfield projects. These sources include academic journals, industry reports, government databases, and financial statements of petroleum companies.

(b). Collect Secondary Data**:** Gather secondary quantitative data from the identified sources. The data collected aligns with the research objectives and covers relevant aspects of net cash flow analysis in greenfield projects (Feineman, 2009; Gonzalez et al., 2019; Ma, 2020; Nesvold & Bratvold, 2023; Ortiz-Volcan et al., 2018; Sinha et al., 2024).

Table 1. Technical and economic parameters for the greenfield study case (Iledare & Fubara, 2017).

Greenfield Data (Parameters)		Units
Recoverable Reserves	1,086,000	MMbbl
Initial Production	10,000	MMbbl/Y
Production Commencement	2020	Year
Build up Phase	3	Years
Plateau Production	85,000	MMbbl/Y
Plateau Phase	6	Years
Initial Production Decline	82,000	MMbbl/Y
Production Economic Limit	6,000	MMbbl/Y
End of Production	2039	Year
Life of Field	19	Years
Oil Price	50	$/Bbl
Oil Variable Cost	7	$/Bbl
Water Variable Cost	3	$/Bbl
Total Capex for the Project	13,000,000	M$
Total Opex During the Project	9,764,050	M$

(c). Define Variables and Measures**:** In the context of net cash flow analysis in petroleum economics, variables may include cash inflows, cash outflows, project costs, revenues, production volumes, and financial (Mian, 2015; Thapar, 2024).

(d). Data Cleaning and Preprocessing**:** Clean and preprocess the collected data to ensure its quality and reliability (Dhall, 2019).

(e). Data Analysis Techniques**:** The author selects appropriate quantitative analysis techniques to analyze the data (Dhall, 2019). This include:

- Descriptive Statistics: Calculate summary statistics such as mean, median, standard deviation, and range to describe the distribution of net cash flows and other relevant variables (Dhall, 2019).
- Regression Analysis: Conduct regression analysis to examine the relationship between independent variables (e.g., project costs, production volumes) and dependent

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variables (e.g., net cash flows) (Azizurrofi & Firdaus, 2019).

- Sensitivity Analysis: Perform sensitivity analysis to evaluate the impact of changes in key variables (e.g., oil prices, production costs) on net cash flows and project economics (Lucchesi, 2019).

Changes of + / - 20% in each of the four inputs were applied to the base scenario, one at a time, and their impacts on the greenfield net cash flow were measured, as described in the table 2.

Table 2. New inputs for sensitivity analysis (Lucchesi, 2019)

Parameters	Low Case (Change of - 20%)	Base Case	High Case (Change of + 20%)
Oil Price	$30/Bbl	$50/Bbl	$70/Bbl
Oil Variable Cost	$5/Bbl	$7/Bbl	$9/Bbl
Water Variable Cost	$1/Bbl	$3/Bbl	$5/Bbl

4. Results and Discussion

4.1. Results

4.1.1. Greenfield Net Cash Flow for Low Case

The base scenario's valuation resulted in a net cash flow (NCF) of $27,748,650, with water variable costs at $3/bbl, oil variable costs at $7/bbl, and an oil price of $50/bbl for the development of 1,086,000 MMbbl over the field's life. Figure 3, a tornado diagram, shows the results of the sensitivity analysis performed for the greenfield project. The horizontal axis represents NCF values, while the vertical axis lists the three parameters analyzed and their impact on the outcome. The middle point of the horizontal axis represents the base scenario, where the NCF is $27,748,650. The orange bars on the right side indicate positive impacts, and the blue bars on the left side indicate negative impacts on the project NCF for changes of +/- 20% in each variable.

The tornado chart shows that the low scenario's valuation resulted in an NCF of $9,815,950, with water variable costs at $1/bbl, oil variable costs at $5/bbl, and an oil price of $30/bbl for the greenfield development. Conversely, the high scenario's valuation resulted in an NCF of $45,681,350, with water variable costs at $5/bbl, oil variable costs at $9/bbl, and an oil price of $70/bbl for the greenfield development. The graph clearly indicates that oil price is the most influential variable in the greenfield project. A fluctuation of -20% in oil price led to a significant decrease in the expected project return, reducing NCF by $9,815,950. Similarly, a 20% increase in oil price generated a substantially higher return, increasing NCF to $45,681,350.

Figure 4 illustrates the net cash flow for the greenfield project under a low case scenario. The field is expected to produce oil for 19 years, from 2020 to 2039, with estimated recoverable reserves of 1,086 million barrels (MMbbl). Over the project's lifespan, it is projected to generate cumulative revenue low case scenario of approximately $32,580,000. Initially, the project requires a capital expenditure (Capex) of $13,000,000. To sustain production, additional operational expenses (Opex) are necessary, including oil fixed costs of $2,000,000, oil variable costs of $5,430,000, water injection costs of $807,650, and workover costs of $1,526,400, totaling $9,764,050.

As shown in Figure 4, the project generates a negative net cash flow (NCF) from 2020 to 2023 due to the high costs associated with exploration, surveying, and drilling activities. However, beginning in 2024, the NCF turns positive and remains so until 2039, driven by peak oil production and high revenue. From 2024 to 2029, the field achieves peak oil production of 85,000 MMbbl per year, resulting in an annual revenue of $2,550,000.

After 2029, production begins to decline due to decreasing reservoir pressure and reduced oil volume, as depicted in Figure 4 and detailed in Table 3. The cumulative oil production for the greenfield project, under the low case scenario, is estimated at 9,815,950 barrels from 2020 to 2039, as shown in Figure 5.

4.1.2. Green Field Net Cash Flow for Base Case

Figure 6 illustrates the net cash flow for the greenfield project under a base case scenario. The field is expected to produce oil for 19 years, from 2020 to 2039, with estimated recoverable reserves of 1,086 million barrels (MMbbl). Over the project's lifespan, it is projected to generate cumulative revenue of approximately $54,300,000. Initially, the project requires a capital expenditure (Capex) of $13,000,000. To sustain production, additional operational expenses (Opex) are necessary, including oil fixed costs of $2,000,000, oil variable costs of $7,602,000, water injection costs of $2,422,950, and workover costs of $1,526,400, totaling $13,551,350.

As shown in Figure 6, the project generates a negative net cash flow (NCF) from 2020 to 2023 due to the high costs associated with exploration, surveying, drilling activities, and other initial expenses. However, beginning in 2024, the NCF turns positive and remains so until 2037, driven by peak oil production and high revenue. From 2024 to 2029, the field achieves peak oil production of 85,000 MMbbl per year, resulting in an annual revenue of $4,250,000. After 2029, production begins to decline due to decreasing reservoir pressure and reduced oil volume, as depicted in Figure 6 and detailed in Table 4.

The cumulative oil production for the greenfield project, under the base case scenario, is estimated at 27,748,650 barrels from 2020 to 2039, as shown in Figure 7.

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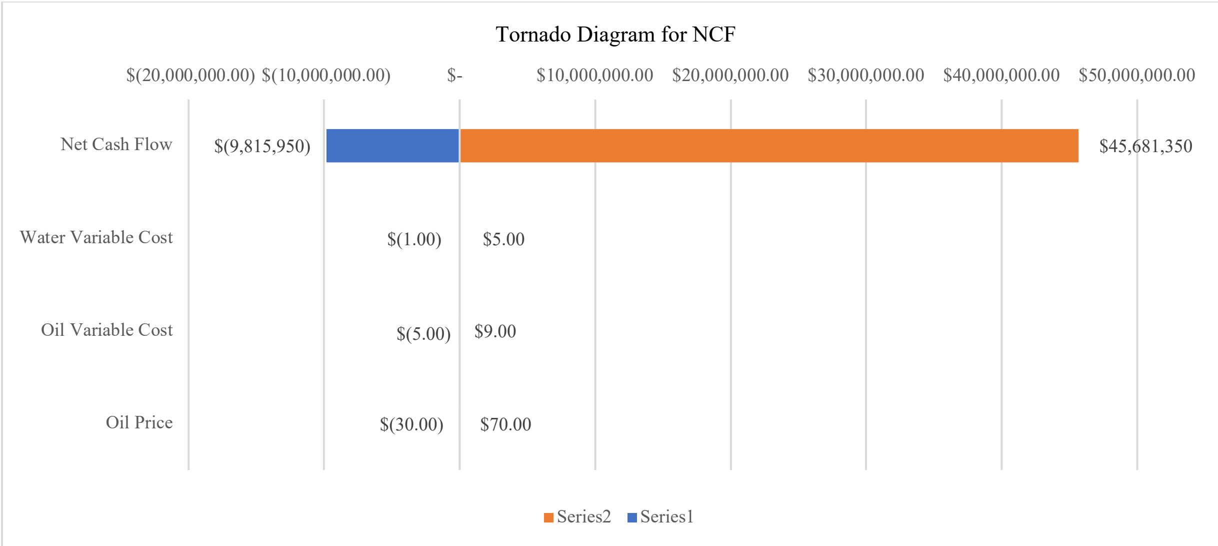

Figure 3. Tornado diagram for NCF

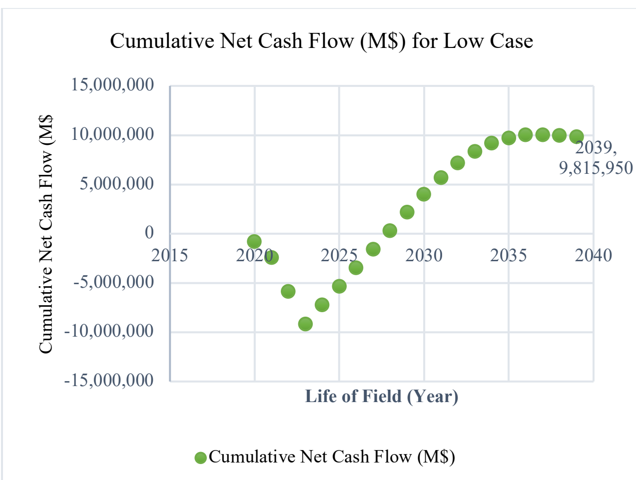

Figure 4. Green field net cash flow for low case

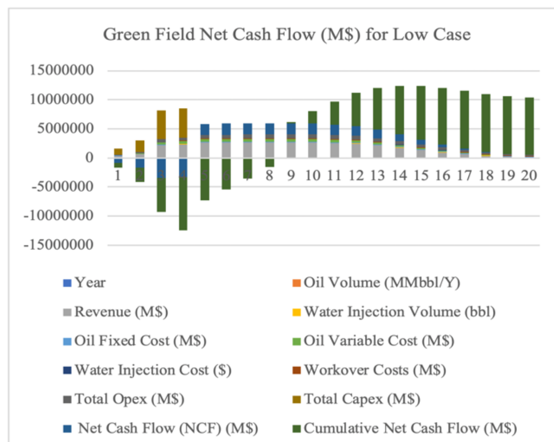

Figure 5. Cumulative net cash flow for low case

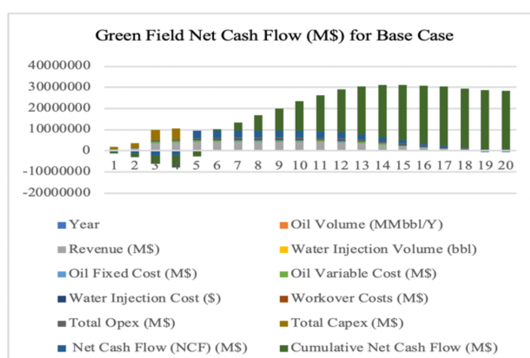

Figure 6. Greenfield net cash flow for base case

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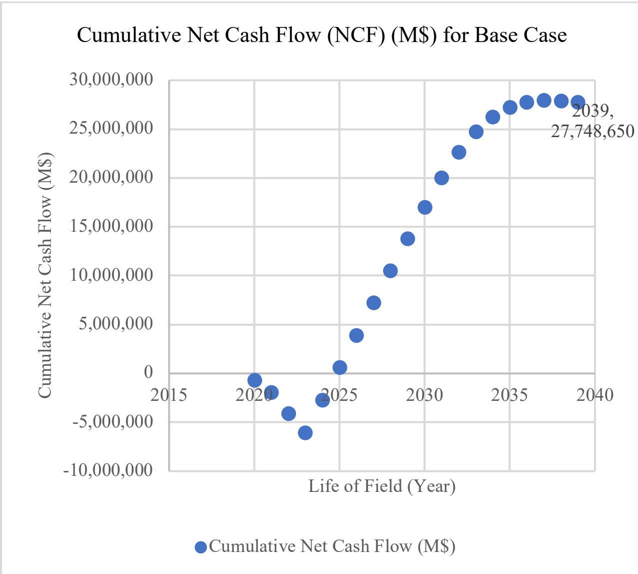

Figure 7. Cumulative net cash flow for base case

4.1.3. Greenfield Net Cash Flow for High Case

Figure 8 illustrates the net cash flow (NCF) for the greenfield project under a high case scenario. The field is expected to produce oil for 19 years, from 2020 to 2039, with estimated recoverable reserves of 1,086 million barrels (MMbbl). Over the project's lifespan, it is projected to generate cumulative revenue of approximately $76,020,000. Initially, the project requires a capital expenditure (Capex) of $13,000,000. To sustain production, additional operational expenses (Opex) are necessary, including oil fixed costs of $2,000,000, oil variable costs of $9,774,000, water injection costs of $4,038,250, and workover costs of $1,526,400, totaling $17,338,650.

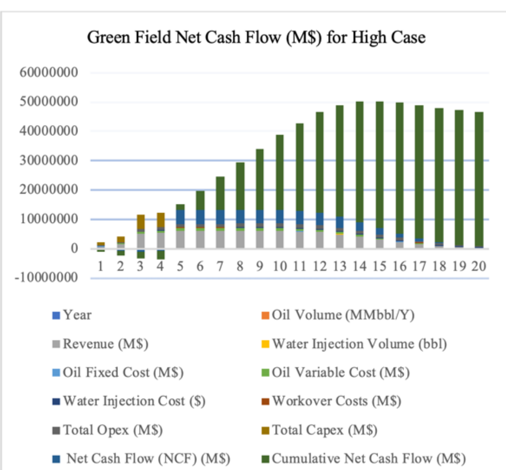

Figure 8. Green field net cash flow for high case

As shown in Figure 8, the project generates a negative NCF from 2020 to 2023 due to the high costs associated with exploration, surveying, drilling activities, and other initial expenses. However, beginning in 2024, the NCF turns positive and remains so until 2038, driven by peak oil production and high revenue. From 2024 to 2029, the field achieves peak oil production of 85,000 MMbbl per year, resulting in an annual revenue of $5,950,000. After 2029, production begins to decline due to decreasing reservoir pressure and reduced oil volume, as depicted in Figure 8 and detailed in Table 5.

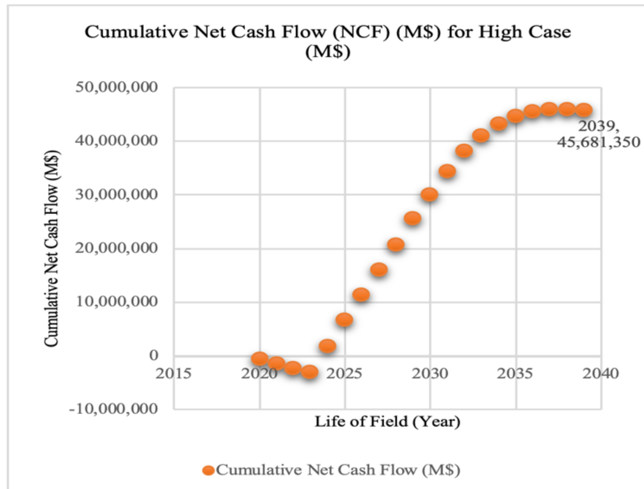

Figure 9. Cumulative net cash flow for high case

The cumulative oil production for the greenfield project, under the high case scenario, is estimated at 45,681,350 barrels from 2020 to 2039, as shown in Figure 9.

4.2. Discussions

The objective of this research was to focuses on a comprehensive NCF analysis of a greenfield oil and gas project, examining low, base, and high case scenarios. This study's net cash flow (NCF) analysis of a greenfield oil and gas project reveals critical insights into the financial viability of such projects under varying economic conditions. By examining low, base, and high case scenarios, research gain a nuanced understanding of how different cost and revenue structures impact the overall financial performance (Ashikwei et al., 2023; Azizurrofi & Firdaus, 2019; Iledare & Fubara, 2017; Lucchesi, 2019; Peacock & Duncan, 2019).

4.2.1. Comparative Analysis

In the base scenario, the project achieves a net cash flow of $27,748,650, assuming an oil price of $50 per barrel, water variable costs of $3 per barrel, and oil variable costs of $7 per barrel. Sensitivity analysis using a tornado diagram highlights the oil price as the most influential variable, with a 20% fluctuation significantly altering the project's NCF. This base scenario aligns with previous studies that emphasize the

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paramount importance of oil prices in determining the economic outcomes of oil and gas projects. For instance, Lucchesi (2019) also identified oil price fluctuations as a critical factor in their NCF analysis of offshore oil projects, demonstrating similar sensitivity to price variations. Under the low case scenario, the project's NCF drops to $9,815,950, driven by an oil price of $30 per barrel and reduced cost structures, including water variable costs of $1 per barrel and oil variable costs of $5 per barrel.

This scenario underscores the challenges faced by greenfield projects in low-price environments. Previous work by Lucchesi (2019) on main factors impacting oil projects return also found that low oil prices substantially impact NCF, often leading to negative cash flows in the early years of production, similar to our findings from 2020 to 2023. Conversely, the high case scenario projects a favorable NCF of $45,681,350, assuming an oil price of $70 per barrel, with water variable costs at $5 per barrel and oil variable costs at $9 per barrel. This scenario suggests that higher oil prices can significantly enhance project profitability, a conclusion also supported by Ashikwei et al., (2023); Azizurrofi & Firdaus, (2019); Grecco & Corp, (1987); Iledare & Fubara, (2017); Lucchesi, (2019); Peacock & Duncan, (2019) in their study on Deepwater oil fields, where they observed substantial improvements in NCF with higher commodity prices.

4.2.2. Project Lifecycle and Financial Performance

Throughout the project's 19-year lifespan (2020-2039), our analysis shows an initial phase of negative NCF from 2020 to 2023 due to high exploration, surveying, and drilling costs. However, from 2024 onwards, the NCF turns positive, peaking during the high production years (2024-2029) and gradually declining as reservoir pressure decreases. This lifecycle pattern is consistent with findings by Khasanov et al., (2013); McGee & Dysert, (1986); Raniolo et al., (2014), who observed similar trends in their NCF analysis of Arctic oil fields, highlighting an initial investment-heavy period followed by years of peak production and eventual decline. The cumulative oil production under the low, base, and high scenarios is estimated at 9,815,950 barrels, 27,748,650 barrels, and 45,681,350 barrels, respectively. These estimates reinforce the critical role of operational efficiency and cost management in maximizing financial returns, as highlighted April et al., (2003); Fleckenstein & Zimmermann, (2013); Ortiz, (2015) in their comprehensive review of onshore oil projects.

4.2.3. Strategic Insights

This study's findings underscore the importance of strategic planning and operational efficiency in navigating the financial uncertainties inherent in greenfield oil and gas projects (Feineman, 2009; Gonzalez et al., 2019; Ma, 2020; Nesvold & Bratvold, 2023; Ortiz-Volcan et al., 2018; Sinha et al., 2024). The significant impact of oil price fluctuations on NCF suggests that robust risk management strategies are essential for mitigating potential financial downsides (Lucchesi, 2019). Additionally, optimizing operational expenses, particularly in the early high-cost phases, can improve the project's overall financial health (Mian, 2015; Thapar, 2024). In conclusion, this study provides valuable insights into the financial dynamics of greenfield oil and gas projects, highlighting the critical factors that influence net cash flow across different economic scenarios (Fanchi & Christiansen, 2017; Mazeel, 2010; Peterson, 2009). By comparing our results with previous research, we affirm the general trends observed in the industry and contribute to a deeper understanding of the financial viability of such projects. These insights can inform future investments and operational planning, ensuring better preparedness for market fluctuations and operational challenges.

5. Conclusions and Implications

Conclusions and implications based on net cash flow analysis of a greenfield oil and gas project:

a) Impact of oil price on NCF: The sensitivity analysis indicates that oil price is the most influential factor affecting the net cash flow (NCF) of the greenfield project. In the low case scenario, a decrease in oil price significantly reduces the NCF to $9,815,950, while an increase in oil price in the high case scenario boosts the NCF to $45,681,350. This demonstrates the critical importance of market conditions on project viability. Consequently, the project’s financial stability heavily relies on favorable oil price trends, necessitating effective risk management strategies to mitigate price volatility.
b) Sustainable production and cost management: Across all scenarios, the project experiences negative NCF during the initial years (2020-2023) due to substantial Capex and Opex required for exploration and development. However, NCF turns positive from 2024 onwards, sustained by peak oil production. Efficient cost management, particularly in controlling variable costs and optimizing operational expenditures, is essential to maintain profitability. The project should focus on cost reduction techniques and technological advancements to enhance operational efficiency and extend positive cash flow periods.
c) Production decline and long-term planning: Post-2029, the NCF begins to decline due to decreasing reservoir pressure and reduced oil volume. The cumulative oil production for the project varies significantly across scenarios, with the low case yielding 9,815,950 barrels and the high case reaching 45,681,350 barrels. Long-term planning and investment in enhanced oil recovery (EOR) techniques will be crucial to mitigate production decline and maximize resource extraction. Strategic planning should include continuous monitoring and adaptive measures to sustain production levels and ensure long-term project success.

6. Limitations and Future Research

6.1. Limitations

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a) Market dependency and price volatility. The net cash flow analysis heavily depends on oil prices, which are subject to significant market volatility. The project's financial outcomes vary greatly with changes in oil prices, as demonstrated by the sensitivity analysis. This reliance on fluctuating oil prices poses a limitation, making long-term financial predictions and planning challenging.
b) Simplified cost assumptions. The analysis assumes fixed variable and operational costs over the project's life. In reality, costs such as maintenance, labor, and materials can fluctuate due to various factors, including inflation and supply chain disruptions. This simplification may lead to an underestimation or overestimation of the actual costs, impacting the accuracy of the net cash flow projections.

6.2. Future Research

a) Incorporation of advanced predictive models. Future research should incorporate advanced predictive models and machine learning algorithms to more accurately forecast oil prices and cost variables. These models can help simulate a wider range of scenarios and provide more robust financial forecasts, reducing the uncertainty associated with market volatility and operational cost fluctuations.
b) Assessment of environmental and regulatory impacts. Further research should evaluate the potential impact of environmental regulations and sustainability practices on net cash flow. As the oil and gas industry faces increasing regulatory scrutiny and a shift towards renewable energy, understanding how these factors influence project economics will be crucial for long-term strategic planning and investment decisions.

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Appendix

Table 3. Net cash flow for the greenfield project under a low case scenario.

Year	Oil Volume (MMbbl/Y)	Revenue (M$)	Water Injection Volume (bbl)	Oil Fixed Cost (M$)	Oil Variable Cost (M$)	Water Injection Cost ($)	Workover Costs (M$)	Total Opex (M$)	Total Capex (M$)	Net Cash Flow (NCF) (M$)	Cumulative Net Cash Flow (M$)
2020	10,000	300,000	0	100,000	50,000	0	0	150,000	1,000,000	-850,000	-850,000
2021	20,000	600,000	0	100,000	100,000	0	18,000	218,000	2,000,000	-1,618,000	-2,468,000
2022	70,000	2,100,000	18,000	100,000	350,000	18,000	39,600	507,600	5,000,000	-3,407,600	-5,875,600
2023	76,000	2,280,000	22,100	100,000	380,000	22,100	72,000	574,100	5,000,000	-3,294,100	-9,169,700
2024	85,000	2,550,000	42,250	100,000	425,000	42,250	75,600	642,850	0	1,907,150	-7,262,550
2025	85,000	2,550,000	45,500	100,000	425,000	45,500	86,400	656,900	0	1,893,100	-5,369,450
2026	85,000	2,550,000	49,400	100,000	425,000	49,400	90,000	664,400	0	1,885,600	-3,483,850
2027	85,000	2,550,000	55,250	100,000	425,000	55,250	90,000	670,250	0	1,879,750	-1,604,100
2028	85,000	2,550,000	55,250	100,000	425,000	55,250	90,000	670,250	0	1,879,750	275,650
2029	85,000	2,550,000	55,250	100,000	425,000	55,250	90,000	670,250	0	1,879,750	2,155,400
2030	82,000	2,460,000	55,250	100,000	410,000	55,250	90,000	655,250	0	1,804,750	3,960,150
2031	79,000	2,370,000	55,250	100,000	395,000	55,250	90,000	640,250	0	1,729,750	5,689,900
2032	69,000	2,070,000	55,250	100,000	345,000	55,250	90,000	590,250	0	1,479,750	7,169,650
2033	57,000	1,710,000	55,250	100,000	285,000	55,250	90,000	530,250	0	1,179,750	8,349,400
2034	43,000	1,290,000	53,300	100,000	215,000	53,300	90,000	458,300	0	831,700	9,181,100
2035	31,000	930,000	51,350	100,000	155,000	51,350	90,000	396,350	0	533,650	9,714,750
2036	20,000	600,000	44,850	100,000	100,000	44,850	90,000	334,850	0	265,150	9,979,900
2037	11,000	330,000	37,050	100,000	55,000	37,050	90,000	282,050	0	47,950	10,027,850
2038	6,000	180,000	27,950	100,000	30,000	27,950	82,800	240,750	0	-60,750	9,967,100
2039	2,000	60,000	29,150	100,000	10,000	29,150	72,000	211,150	0	-151,150	9,815,950
	1,086,000	**32,580,000**	**807,650**	**2,000,000**	**5,430,000**	**807,650**	**1,526,400**	**9,764,050**	**13,000,000**	**9,815,950**	

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Table 4. Net cash flow for the greenfield project under a base case scenario.

Year	Oil Volume (MMbbl/Y)	Revenue (M$)	Water Injection Volume (bbl)	Oil Fixed Cost (M$)	Oil Variable Cost (M$)	Water Injection Cost ($)	Workover Costs (M$)	Total Opex (M$)	Total Capex (M$)	Net Cash Flow (NCF) (M$)	Cumulative Net Cash Flow (M$)
2020	10,000	500,000	0	100,000	70,000	0	0	170,000	1,000,000	-670,000	-670,000
2021	20,000	1,000,000	0	100,000	140,000	0	18,000	258,000	2,000,000	-1,258,000	-1,928,000
2022	70,000	3,500,000	18,000	100,000	490,000	54,000	39,600	683,600	5,000,000	-2,183,600	-4,111,600
2023	76,000	3,800,000	22,100	100,000	532,000	66,300	72,000	770,300	5,000,000	-1,970,300	-6,081,900
2024	85,000	4,250,000	42,250	100,000	595,000	126,750	75,600	897,350	0	3,352,650	-2,729,250
2025	85,000	4,250,000	45,500	100,000	595,000	136,500	86,400	917,900	0	3,332,100	602,850
2026	85,000	4,250,000	49,400	100,000	595,000	148,200	90,000	933,200	0	3,316,800	3,919,650
2027	85,000	4,250,000	55,250	100,000	595,000	165,750	90,000	950,750	0	3,299,250	7,218,900
2028	85,000	4,250,000	55,250	100,000	595,000	165,750	90,000	950,750	0	3,299,250	10,518,150
2029	85,000	4,250,000	55,250	100,000	595,000	165,750	90,000	950,750	0	3,299,250	13,817,400
2030	82,000	4,100,000	55,250	100,000	574,000	165,750	90,000	929,750	0	3,170,250	16,987,650
2031	79,000	3,950,000	55,250	100,000	553,000	165,750	90,000	908,750	0	3,041,250	20,028,900
2032	69,000	3,450,000	55,250	100,000	483,000	165,750	90,000	838,750	0	2,611,250	22,640,150
2033	57,000	2,850,000	55,250	100,000	399,000	165,750	90,000	754,750	0	2,095,250	24,735,400
2034	43,000	2,150,000	53,300	100,000	301,000	159,900	90,000	650,900	0	1,499,100	26,234,500
2035	31,000	1,550,000	51,350	100,000	217,000	154,050	90,000	561,050	0	988,950	27,223,450
2036	20,000	1,000,000	44,850	100,000	140,000	134,550	90,000	464,550	0	535,450	27,758,900
2037	11,000	550,000	37,050	100,000	77,000	111,150	90,000	378,150	0	171,850	27,930,750
2038	6,000	300,000	27,950	100,000	42,000	83,850	82,800	308,650	0	-8,650	27,922,100
2039	2,000	100,000	29,150	100,000	14,000	87,450	72,000	273,450	0	-173,450	27,748,650
	1,086,000	**54,300,000**	**807,650**	**2,000,000**	**7,602,000**	**2,422,950**	**1,526,400**	**13,551,350**	**13,000,000**	**27,748,650**	

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Table 5. Net cash flow for the greenfield project under a high case scenario.

Year	Oil Volume (MMbbl/Y)	Revenue (M$)	Water Injection Volume (bbl)	Oil Fixed Cost (M$)	Oil Variable Cost (M$)	Water Injection Cost ($)	Workover Costs (M$)	Total Opex (M$)	Total Capex (M$)	Net Cash Flow (NCF) (M$)	Cumulative Net Cash Flow (M$)
2020	10,000	700,000	0	100,000	90,000	0	0	190,000	1,000,000	-490,000	-490,000
2021	20,000	1,400,000	0	100,000	180,000	0	18,000	298,000	2,000,000	-898,000	-1,388,000
2022	70,000	4,900,000	18,000	100,000	630,000	90,000	39,600	859,600	5,000,000	-959,600	-2,347,600
2023	76,000	5,320,000	22,100	100,000	684,000	110,500	72,000	966,500	5,000,000	-646,500	-2,994,100
2024	85,000	5,950,000	42,250	100,000	765,000	211,250	75,600	1,151,850	0	4,798,150	1,804,050
2025	85,000	5,950,000	45,500	100,000	765,000	227,500	86,400	1,178,900	0	4,771,100	6,575,150
2026	85,000	5,950,000	49,400	100,000	765,000	247,000	90,000	1,202,000	0	4,748,000	11,323,150
2027	85,000	5,950,000	55,250	100,000	765,000	276,250	90,000	1,231,250	0	4,718,750	16,041,900
2028	85,000	5,950,000	55,250	100,000	765,000	276,250	90,000	1,231,250	0	4,718,750	20,760,650
2029	85,000	5,950,000	55,250	100,000	765,000	276,250	90,000	1,231,250	0	4,718,750	25,479,400
2030	82,000	5,740,000	55,250	100,000	738,000	276,250	90,000	1,204,250	0	4,535,750	30,015,150
2031	79,000	5,530,000	55,250	100,000	711,000	276,250	90,000	1,177,250	0	4,352,750	34,367,900
2032	69,000	4,830,000	55,250	100,000	621,000	276,250	90,000	1,087,250	0	3,742,750	38,110,650
2033	57,000	3,990,000	55,250	100,000	513,000	276,250	90,000	979,250	0	3,010,750	41,121,400
2034	43,000	3,010,000	53,300	100,000	387,000	266,500	90,000	843,500	0	2,166,500	43,287,900
2035	31,000	2,170,000	51,350	100,000	279,000	256,750	90,000	725,750	0	1,444,250	44,732,150
2036	20,000	1,400,000	44,850	100,000	180,000	224,250	90,000	594,250	0	805,750	45,537,900
2037	11,000	770,000	37,050	100,000	99,000	185,250	90,000	474,250	0	295,750	45,833,650
2038	6,000	420,000	27,950	100,000	54,000	139,750	82,800	376,550	0	43,450	45,877,100
2039	2,000	140,000	29,150	100,000	18,000	145,750	72,000	335,750	0	-195,750	45,681,350
	1,086,000	**76,020,000**	**807,650**	**2,000,000**	**9,774,000**	**4,038,250**	**1,526,400**	**17,338,650**	**13,000,000**	**45,681,350**	