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Article

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Economic Risk of Wind Farm Investments in UAE: Evaluation through Real Options Approach

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ABSTRACT

This study examines the potential of business investments in wind offshore farm in the United Arab Emirates through projection of five different possible scenarios. The evaluation was done by using real option approach and Monte Carlo simulation imbibing the potential risk on investment with the source of funds used. Our analysis indicates that the return on investments and the risk on delay option remain at the highest degree if the project is financed with 50% government support and 50% investor's own equity. On the contrary, a 100% bank-financed project yields lowest investments return and lowest risk option to delay. This implies that the financial leverage and the high bank interest rate are significant factors in influencing the economic risk and return of the wind farm project. This research contributes to the existing literature by highlighting the significance of real options application in the most-sought energy sector - wind farm. Moreover, this will pave way for small and medium enterprises (SMEs) in the UAE to invest in this energy field.

Keywords: Renewable Energy, Wind Farm Investments, Real Options, Economic Risk
JEL Classifications: E22, G11, O22, Q20

1. INTRODUCTION

Economic development in any country leads to more power consumption. Internationally, the energy demand is increasing due to economic growth, industrialization, population growth and urbanization. Recent statistics indicate that there are more than a billion people living without electricity while another three billion people are using traditional source of energy (Salim and Alsyouf, 2020). To fulfil the extra demand of power generation, countries are setting up goals to incentivize renewable energy to better control the climate change and reduce the carbon emission. The more utilization of renewable energy with new technology, the more cost reduction in generating the power. Wind and solar energy are leading the transformation of renewable energy sector as it is expected to generate 6044 GW from wind energy and 8519 GW from solar energy by 2050. With technological advancement, onshore wind energy cost is observed to be reduced to reach to the least cost fossil fuel alternatives as it is one of the fastest growing and cost competitive technology. The offshore wind energy, on the other hand, is expected to increase by 17% with the deployment of 1000 GW from total capacity by 2050. A focus on advancement in wind turbine technology is helping to reduce the cost of capital of the projects. The cost of offshore wind energy has dropped by 5% from 2010 to 2018 and it is expected to further go down from \$4353 to range between \$1400 and \$2800 per kilo watt which will even be lower than fossil fuel range by 2030 (IRENA, 2019). UAE is the leading country in investing in renewable energy. With a recent implementation of 2-MW production of wind energy in Sir Bani Yas Island in Abu Dhabi which uses 850 KW wind turbine, the UAE is planning to expand it to 300 MW in 2030 (Basha et al., 2021). UAE is not only investing inside the country, but also in neighboring gulf countries. For example, Masdar a subsidy of Mubadala such as Dhofar wind farm the first utility scale in GCC region with 50 MW in Oman and Dumat Al Jandal with 400 MW capacity in Saudi Arabia are some significant investment projects in addition to its investment in 12 wind farms around the world (Connelly and Xydis, 2021).

With the current strategy plans, UAE need to accelerate the implementation of this kind of projects not only in the government sector but also in the private sector. However, investors think investing in renewable energy has a lot of uncertainty. On other hand, all research and projects done in the United Arab Emirates context are focusing only at government level (Salimi et al., 2022). Therefore, there is a lack of literature focusing on economic risk evaluation for SMEs.

In this paper, we aim to attempt the following research question: What is the economic risk of investing in offshore wind farm in the UAE?

To explore an appropriate answer to this question, we evaluated the risk under the ambit of return on investments and the financing mix generally used by the SMEs. It is very much expected that the findings of this research will make a significant addition to the existing literature from two perspectives. First, our study evaluates one of the most emerging business segments - the wind energy in the UAE. Secondly, the evaluation is done using Monte Carlo simulation and delay option approach as the UAE business environment is full of uncertainties. Considering five different scenarios based on the sources of funds and interest rate, the results are expected to provide a much clear direction for the investors and the policymakers with regards to the potential investment opportunities in this business segment.

The rest of the paper is organized as follows: Section-2 provides brief literature review; Section-3 deals with data and methodology; Section-4 presents results and analysis; Section-5 covers the discussion; and conclusion is presented in Section-6.

2. LITERATURE REVIEW

2.1. Geographical Potential

Wind energy generation resources have been previously evaluated in Gulf countries. There exists imbalance in the evaluation of onshore and offshore wind energy generating companies. Nevertheless, global literature suggests that offshore wind is stronger for energy generation compared to onshore wind (De Azevedo et al., 2020). The evaluation of wind resources in the Gulf indicates that GCC countries have reasonably good offshore wind potential. Especially the central Arabian Gulf receives higher annual average wind speed (8–9 m s−1), at 50 m elevation (Aboobacker et al., 2021; Alharbi and Csala, 2021a). The northwest (shamal) wind is dominant over the Gulf throughout the year (Aboobacker et al., 2021). Through the scientific reports, it is noted that the wind speeds in Arabian Gulf ranges between 2.35 and 5.1 m s−1 at a height of 10 m. A feasibility study on UAE coastal sides using Geographic Information Systems (GIS), indicates that Abu Dhabi's coasts around Delma Island and North of Jabal Barakah in the Western Region are having high potential for development of offshore wind farms with speed ranging between 5 and 6 m/s, also having a suitable water depth at the same time (Fasel et al., 2021; Saleous et al., 2016). Thus, the UAE's geography has been scientifically proven to be a potential location for the harvesting of wind energy through different technologies.

2.2. Energy Policies

Strong policy and regulation support are key factors to lead the implementation of renewable energy projects. The European Climate law "European Green Deal" was introduced with the aim of achieving net-zero greenhouse gas emissions by 2050. One of the main pillars of the green deal is the availability and attraction for investors to invest in the renewable energy (Lu et al., 2020). The European Commission raised funds for energy transformation projects (Sobotka et al., 2021), that would offer business opportunities for investors across the globe to invest in renewable energy related projects. Denmark, being one of leading European countries in the field of wind energy policy development, first introduced energy policy in 1970. After many enhancements to the original policy, developed the National Energy plans for energy security, self-sufficiency, efficiency, and greenhouse gas reduction. Later, the Danish Energy Agency was formed to analyze and solve challenges related to electricity generation through wind energy (Dorrell and Lee, 2020; Gao et al., 2019; Lu et al., 2020). Similarly, USA incorporated energy policy in the economic system for the expansion of clean energy production. They established the Energy Independence and Security Act (EISA) and Energy Policy Act (EPAct) to analyze the opportunities and challenges in energy conservation and efficiency (Lu et al., 2020). Additionally, Germany took an initiative for sustainable development through solar investments. In 2011, they introduced "Energiewende" policy to reduce the fossil fuel consumption from 80% to 20% by 2050 (Lu et al., 2020). Further, UK initiated many similar national policies such as the green deal, Feed-In Tariffs, Energy Opportunities Schemes, and climate change levy with the aim of increasing the cleaner energy input to the economic system (Lu et al., 2020).

The oil crisis and climate change pushed UAE to come up with an energy policy aiming to reduce carbon footprint down to 70% by 2050. This target can be achieved through generating energy from the following resources: 44% of clean energy, 38% of gas, 12% of clean coal, and 6% of nuclear energy. However, for the proposed strategy to meet the 2050 goals for emirates, it may depend on the several internal and external factors. Initiatives are taken from each emirate, led by Abu Dhabi and Dubai, to implement many clean energy projects such as: solar rooftop, renewable fundings, building technical and socio-economic capabilities, skill development, legislation formulation, and building infrastructure, such as, Mohammed bin Rashed Al Maktoum solar park in Dubai and Masdar city in Abu Dhabi. On the other hand, investment in wind projects in UAE is still in nascent stage.[1] Given the geographical location of UAE, there is a great potential to harvest wind energy and invest in it. In addition to higher number of sunny days, the benefit for UAE also lies in its coastal region for implementation of offshore wind harvesting.

2.3. Subsidies for Clean Business

Existing theories on the subsidies suggested that subsidies assist in economic activities. Given the nature of energy markets where

1 UAE state of Energy Report 2019

projects require high investment costs and such investments are irreversible, Government may boost the emerging renewable energy market by offering the subsidies to mitigate the investors' risk. According to Kapoor et al., there is a strong positive relationship between subsidized credit to small and medium enterprises and their growth. (Kapoor et al., 2017). There are many examples of such subsidies by the Government in many countries. The Korean government intended to stop subsidizing some fossil fuels in 2020 and replace them with renewable energy subsidies. That decision was reversed after research was performed in Korea to study the impact of the decision in the economy using general equilibrium model suggested that oblation of fusel fuel subsidies might lead to significant reduction in domestic CO_2 emissions, but it would have a very minimal effect on the economy (Park et al., 2021)

The government subsidies in renewable energy could be direct or indirect through tax return. Indirect subsidies have a greater impact on the production of green innovation in the energy sector compared to direct subsidies (Lu et al., 2021). US rely more on government subsidies in clean energy through tax reduction while EU clean energy policy creates strong commitment to competitive and market-based mechanisms other than subsidies (Mormann, 2021). The government in Germany and Denmark supports the construction of onshore and offshore wind farms through initial subsidies to municipalities that support the construction of offshore wind farms. In addition, Denmark government grants a subsidy for energy production at the rate of 25 DKK for 1 kWh above the market price while German government provides subsidies for 20 years (Dawid, 2018) that has recently attracted investors in this sector.

2.4. FIT/FIP/Quota (Start point- Market Entry Strategy)

Feed In Tariff (FIT) guarantees the purchase of renewable energy power at a specific price which is revised every year depending on local conditions. With this pricing policy mechanism, the fixed cost for generating electricity from renewable energy can be covered (Nakano et al., 2017). Some countries, such as Denmark, offer FIT contracts that could extend for 8-15 years or even 30 years in specific cases. The policy goal is to offer a cost-based compensation to renewable energy producers to mitigate risk. On other hand, termination of FIT policy before market matures can lead to cost increment and negative economic impact, for instance Denmark in 2004 terminated FIT policy support in 2004 (Gao et al., 2019). A similar study from Japan on FIT impact also validated the coherent result of the positive impact of FIT on renewable energy expansion (Nakano et al., 2017).

Renewable Portfolio Standard (RPS) was created to determine the weight of obligation for renewable energy consumption based on the government setup. It's been widely used in many countries to guarantee the consumption of the renewable energy power through quotas. The weight obligation could be achieved by purchasing the renewable energy through wholesale electricity market or purchasing green certificate voluntarily. The Renewable portfolio standard in the United States, Renewable obligation in the United Kingdom, and Mandatory renewable energy target in Australia are few examples of the implantation of those policies (Tang and Zhang, 2019). According to Bowen and Lacombe, RPS has a significant impact on the share of renewable generation based on a study done in the US. It also encourages trading of power energy between states to fulfil their obligations (Bowen and Lacombe, 2017)

2.5. Regulatory Support

As part of Dubai Electricity and Water Authority - DEWA's green initiatives, the Dubai Government launched Dubai Green Fund (DGF), an impact investor. In line with Dubai's vision for the future of sustainability, Dubai Green Fund is the first specialized fund to invest in green projects in the region which is focusing in the following sectors:

- Clean energy production
- Energy and water efficiency
- Water and waste management
- Sustainable living
- Green transportation and logistics
- Green real estate
- Sustainable agriculture.

Samples of investments that is supported from DGF is Mohammed Bin Rashid Al Maktoum solar park-phase 4, Dubai international Airport energy efficiency project, and Economic World Zone (JAFZA) for green energy power generation using solar PV and CSP[2].

Khalifa fund, established in 2007 by the Abu Dhabi government, supports small and medium enterprises. It assists nationals and international businesses to contribute to economic growth. The funds provided could reach up to 10 million AED to support small industrial projects with an own contribution of 30% and repayment period of 60 months with an interest rate of 4% starting from the second 3 million AED[3]. Another initiative established by Abu Dhabi government managed by Abu investment office to fund startups projects that focus on innovation and ecosystem called Ghadan Fund[4]. Ghadan Fund which has around 535 million to be utilized, consider investment in renewable energy as one of the highest demand projects that will allow Abu Dhabi to be committed to its future strategy[5].

2.6. Incentives for Renewable/Clean Entrepreneurships or Incumbent Organizations

Foreign direct investment (FDI) plays an important role in boosting the economic development of any country. United Arab Emirates was basically dependent on oil and gas as the main source of wealth; however, to address the environmental sustainability, dependency is to be reduced through several projects. FDI is introduced in UAE and investment authority was established to maintain financial growth of the UAE wealth, custodian for UAE investment and advise the government's policies in economic and industrial matters. Foreign investment laws have been improved

2 Dubai Green Fund (DGF):https://dgf.ae/about-us/
3 Khalifa Fund for Enterprise development https://www.khalifafund.ae/aboutus
4 Ghadan
5 Sectors (investinabudhabi.ae)

to attract as many foreign investments as possible. UAE has the least restrictive non-tariff barrier, trade friendly environment, easy to access oil resources, low energy cost, a willingness to diversify the economy and a high purchasing power, no direct Taxation and law VAT. In addition to that UAE introduced new foreign rules in 2019 giving more flexibility in business ownership in certain economic sectors. This leads the country to be most opened country for foreign business with FDI of more than 14% (Mosteanu and Alghaddaf, n.d.).

Renewal Energy entrepreneurs have different characteristics than other entrepreneurs in other fields. The incentives that could motivate renewable energy entrepreneurs are categorized into four sections: Financial, energy utilization, environmental, and social incentives. Financial motivated entrepreneur is focusing on seeking for profit from increasing the sales and cost reduction. Energy utilization entrepreneur is focusing on used the produced energy such as self-consumption. Environmental and sustainability entrepreneur is motivated by producing a clean energy, reduce the pollution and advanced climate change and mitigation efforts. While social oriented entrepreneur motivation is to create new jobs and socioeconomic improvement. It could be from private, public, or third sector such as state-owned enterprises (Eitan et al., 2020).

2.7. Bank Loans (Low Cost of Borrowing)

Small and Medium Enterprise (SME) is a critical role-playing segment in any economy. Bank loan is the main source of SME financing. Loan size, costs, maturity date, collateral required and the process of obtaining the loan are factors that need to be taken in consideration to approve SME loans (Rubin and Ben-Aharon, 2021). Moreover, the cost of business credit is different from one country to another as each country has different firm riskiness and indebtedness. In addition, the higher approval rate of riskier application bank can have, the higher interest rate in its entire portfolio (McCann and Carroll, 2019). A study of UAE banking behavior towards small business financing found that the availability of financial resources and deposits of the banks had the highest impact on SME lending (Abbas Ahmed and Ali Saber Ali, 2020). By taking the advantage of interest rate in the UAE, SME has higher potential borrowings from bank with low interest rate.

2.8. Existing Evaluation Methods

Net present value (NPV) approach is the most widely-used approach to emulate the profitability and levelized wind energy cost by discounting all cash flows over the lifetime of the investment. The discount rate should be properly estimated to consider the time value of the money allowing the computation of project value with different risk profiles. It is usually combined by using Internal Rate of Return (IRR) and defining the payback period. The NPV method can be found in many research articles that have used the optimal FIT rate for onshore wind energy in Malaysia and locating wind energy projects in India (Albani et al., 2017; Sharma and Agrawal, 2017).

2.9. Real Options in Applied Context

Real option is another valuation approach used in investment decisions making. It depends on combining the uncertainty and flexibility options available in real world (Agaton and Karl, 2018). The main characteristics of energy projects that it is irreversible with huge rate of uncertainty. NPV technique is usually used to evaluate the investment to either invest now or never and it is not adding the flexibility and uncertainty options available in the real worlds. Real option approach allows to evaluate the energy projects options in terms of uncertainty in addition to evaluate the flexibility options such as expansion, abandonment, or postponement in specific time (Nunes et al., 2021).

The uncertainty evaluation in real option approach is put in three categories. The first is the market uncertainty which is related to external market behaviors such as exchange rate, inflation, market price, products demand, interest rate. The second category is the technical uncertainty which is the one related to internal market behaviors such as oil field reserve, solar radiation, wind speed in the city or water flow of the river. And the third category is strategic uncertainty which relates to economic environment such as auction movement or entry cost. On other hand timing is another factor evaluated using real option approach. By evaluating the uncertainty available to the project, you will be able to decide when is the best time to invest, to expand, to postpone, or even to shut down the project (Nunes et al., 2021). Real option approach used in many literatures to evaluate waste to energy investments. One example It is used to compare the option values, the value of waiting, and the perfect time to switch technology from landfill to waste to energy (Agaton et al., 2020). Another example used is real option approach to evaluate the regulatory risk of wind power energy in Spain and Portugal by using Mote Carlo to simulate the data (Sisodia et al., 2016).

2.10. Policy

To establish entrepreneurship in the United Arab Emirates, the government set some policies to facilitate the process and attract the international investors. Government is granting 10 years visa for international investors, high skilled workers in medical, science and research, in addition to entrepreneurs and innovators (Aljarwan et al., 2019). In addition to that, Government introduced bankruptcy law to promote debtor-friendly rescue culture that encourages the entrepreneurs to take risk without worrying about bankruptcy. However they need minimum startup cost of AED10000 to ensure the commitment of not to flee and as a compensation of tax- free framework (Aljarwan et al., 2019). There are many initiatives from government to support entrepreneur startups such as The Dubai Future Accelerators (DFA) which offers free space and zero setup costs, Sheraa which offers startup set up in free zone with low cost, on other hand there are few private initiatives such as Krypto labs from Abu Dhabi Financial Group, e25 from Emaar, and Sandooq Al Watan funds from top Emirati business men to fund research and development and incubate entrepreneur startups (Aljarwan et al., 2019). Government is the major factor in the framework that effect entrepreneurship while academia is the second factor playing an effective role in reshaping the entrepreneurship in the UAE (Aljarwan et al., 2019). Entrepreneurship course should be taught in universities to build up a culture that accept the risk and failure in addition to the knowledge to create fruitful environment of a successful entrepreneurship (Aljarwan et al., 2019; Mohammed and Hamdan, n.d.).

3. DATA AND METHODOLOGY

3.1. Data Assumption and Method

We depended on the report issued by National renewable energy Laboratory in 2019 to get estimation of cost of electricity generated from wind turbine using 6.1-MW floating Bottom fixed Wind Turbine (Stehly et al., 2019). Table 1 is summarizing the variables used in the project cost estimation. With total cost of capital for the initial year is $56966 using 600 MW capacity to be able to produce 2828800 KWH per year. Taking in consideration that the installation cost is $93.1 per MWH and operation and maintenance is $0.0391 per MWH, the cost is assumed to be similar in the initial year across all scenarios.

In Real option approach, the initial investment is estimated to be $56966.06 for all scenarios while the actual cash flows were calculated using the NPV for each scenario, the interest rate, and the project life which is estimated to be 25 years. In addition, the annualized standard deviation is set to be 20%, riskless rate is 5% and dividend yield is 4% as presented in Table 2. Therefore, the delay option value is calculated for each scenario to evaluate its risk.

In this project five scenarios are analyzed based on the financial assumption to give the investors clear future idea about investing in renewable energy and in offshore wind energy in specific. The risk analysis is done to NPV to find the possibilities using Monte Carlo simulation with 5000 iterations with the project lifetime of 25 years.

3.2. Presentation of Scenarios

The following is illustration of each scenario to test the effect on return on investment:

3.2.1. Scenario 1

Depending on the strategic plans, UAE is supporting the projects in renewable energy. Therefore, many sources of funds are provided from government to support this kind of projects with low interest rate that does not exceed 4%. Ghadan fund is one of the initiatives that is used in this scenario. Assuming that the investors have 50% of its initial cost of the project and they only need to finance 50% from Ghadan Funds with interest rate of 4%. The underpinning of this scenario is based on the fact that SMEs get access to this source of funds under the "government support initiatives."

Table 1: Value assigned for project using 6.1 MW floating bottom *fixed wind turbine*

Variables	Value
Installation cost per MWh	$93.1
Operation and maintenance per MWh	$0.0391
Capacity in MW	600
Energy produced kWh per year	2828800
Electricity selling price per kWh for business	$0.01

Table 2: Real option variables

Variables	Value
Annualized standard deviation	20%
Initial investment	$56,966.06
Number of years	25
Riskless rate	5%
Annualized dividend yield	4%

Hypothesis 1: Fifty percent support from Ghadan fund may lead to high return on investment and lowest delay option value.

3.2.2. Scenario 2

In this scenario, we assume that the investors do not have access to government support funds or initiatives, and therefore, they partially depend on bank loans to finance the projects. In this case, 50% will be financed from the bank with interest rate of 10% while 50% will be the owners' equity. This mix of financing may give some leverage benefits to the investors indicating high returns on investment.

Hypothesis 2: Fifty percent support from bank may lead to high return on investment and lowest delay option value.

3.2.3. Scenario 3

The third scenario is considering that the investors have full agreement with the government so the entire project can be financed by the Ghadan Fund with 4% interest rate. This lower interest rate will certainly give investors' some competitive advantage and may result into higher returns on investments.

Hypothesis 3: Full support from Ghadan fund may lead to higher return on investment compared to the first scenario and lowest delay option value.

3.2.4. Scenario 4

In this scenario, we assume that the investors have no equity and Ghadan fund will support the project by only 50% with interest rate of 4% and the remaining 50% will be financed by the bank with interest rate of 10%. This will enable the company to save on interest payments which could have been otherwise dispensed with the 100% bank financing.

Hypothesis 4: Having half of the support from Ghadan fund and other half from the bank may lead to higher return on investment and lowest delay option value.

3.2.5. Scenario 5

In scenario 5, we assume that the projects need to start now, and the investors are not able to finance the project on their own. Since they need to start immediately, 100% of the initial cost will be financed by the bank with 10% interest rate.

Hypothesis 5: All fund support from bank may lead to higher return on investment and lowest delay option value.

4. RESULTS AND ANALYSIS

Based on the five different scenarios using some financial assumptions, we present our results here.

4.1. Scenario 1 (50% Ghadan Fund, 50% Owner)

In this scenario we assumed that the project will be financed 50% from Ghadan Fund and 50% from owner equity. The assumption

Figure 1: Net present value Scenario 1- all values in millions; Authors' estimate

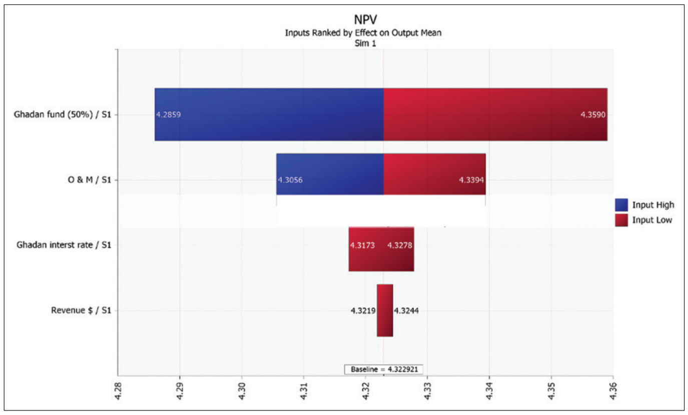


Figure 2: Delay option for scenario 1; Authors' estimate

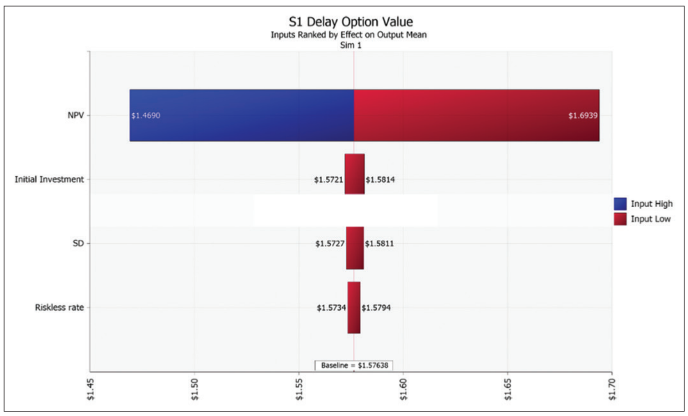


Figure 3: Net present value for scenario 2; Authors' estimate

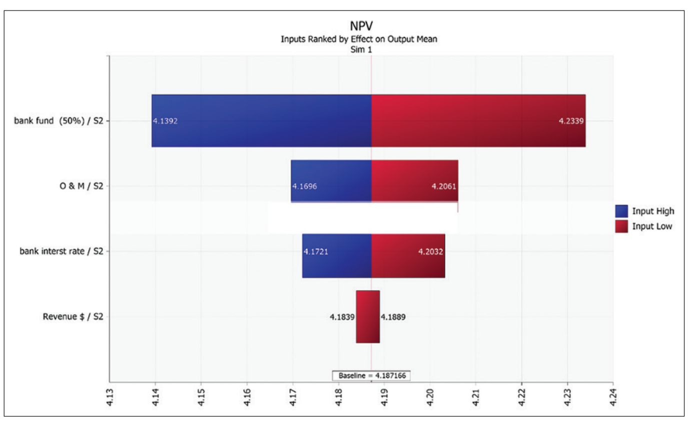


Figure 4: Delay option for scenario 2; Authors' estimate

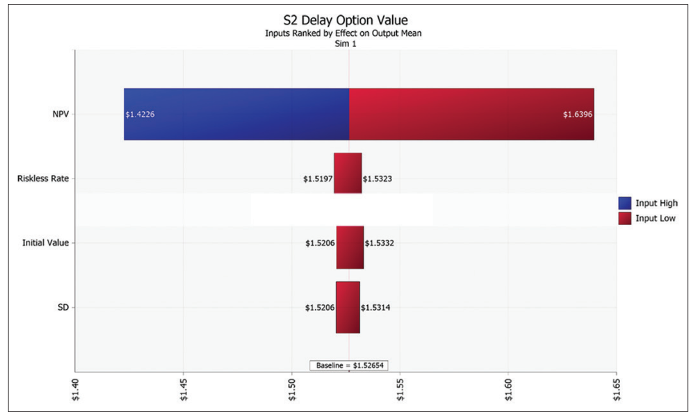


Figure 5: Net present value for scenario 3; Authors' estimate

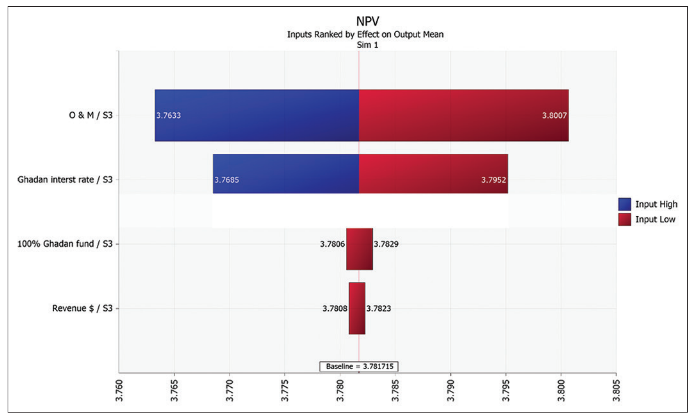
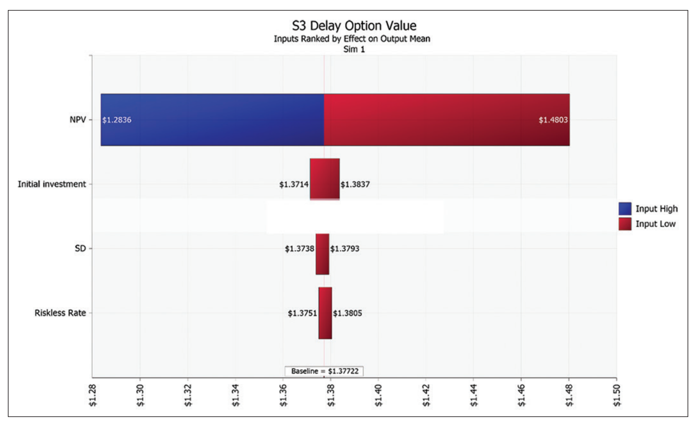


Figure 6: Delay option for scenario 3; Authors' estimate



of this scenario that high return on investment is expected. With Monte Carlo simulation with 5000 iteration and NPV Base line 4.323 million dollars, the amount of fund received from Ghadan fund is the most significant variable that resulted with high NPV of 4.3590 million dollars and 4.2859 million dollars in the worst scenario as shown in Figure 1. While operation and maintenance are the second variable that affects NPV with a range of 4.3394-4.3056 million dollars. Electricity sales and revenue is considered the least important variable affecting the NPV of this project. In delay option as shown in Figure 2, the project in the best-case scenario will have additional cash investment of 1.47 million dollar while it could lose 1.7 million dollars as worst-case scenario. With the positive NPV and risk on delay being $1.6 million, the project in this scenario is accepted.

4.2. Scenario 2 (50% Bank Borrowing with 10% Interest Rate, 50% Owner)

This scenario reflects the fact that government fund is not available and hence replaced by the bank borrowing of equal proportion i.e. 50% with an interest rate of 10% while the remaining fund will be contributed by the owner. The Figure 3 depicts that the amount of bank fund is the most important variable that affects the project NPV with 4.234 million dollars in the best case and 4.139 million dollars in the worst case. Operation and maintenance and bank interest rate are

Figure 7: Net present value for scenario 4; Authors' estimate

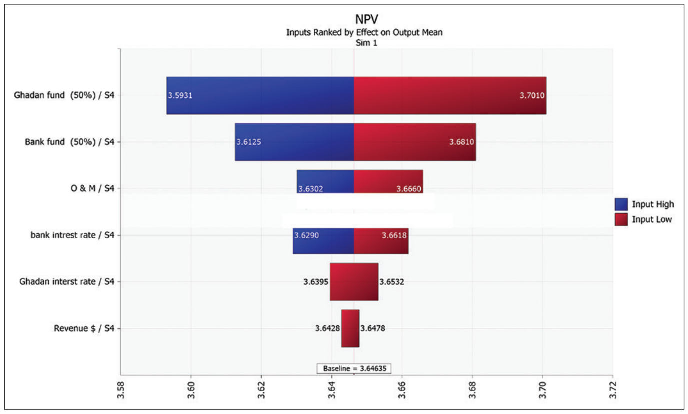
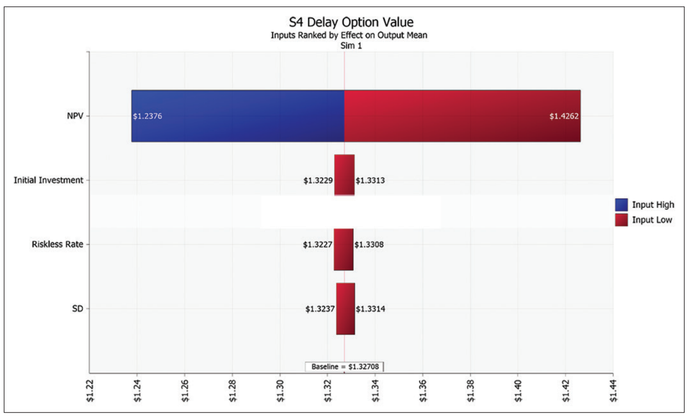


Figure 8: Delay option for scenario 4; Authors' estimate



almost affecting the NPV similarly showing the range of 4.06 million dollars to 4.169 million dollars in operation and maintenance cost and 4.23 million dollars to 4.172 million dollars as bank interest rate respectively. While Figure 4 in delay option shows the project could generate 1.42 million dollars in the best case while it could lose 1.63 million dollars in the worst case. However, with total positive NPV and risk rate of 1.5 million dollars, the project should be accepted.

4.3. Scenario 3 (100% Ghadan Fund)

Scenario 3 is developed on the assumption that there will be 100% support from the Ghadan fund, and therefore, no owner's equity. It reflected in Figure 5 that Operation and maintenance is the most important variable that affect the NPV with 3.8 million dollars as best case and 3.763 million dollars as in worst case. In addition, that Ghadan interest rate is ranked the second important variable with range of 3.95 million dollars to 3.768 million dollars. If the project is delayed it could generate 1.3 extra million dollars or lose 1.5 million dollars with risk of 1.37 million dollars on average as shown in Figure 6. Therefore, with positive NPV and average delay risk, the project should be accepted.

4.4. Scenario 4 (50% Ghadan Fund, 50% Bank Borrowing with 10 % Interest Rate)

Our assumption in this scenario that 50% of the project will be financed from the bank with 10% interest rate and 50% will be supported from Ghadan Fund. With 5000 iterations in Monte Carlo simulation and NPV base line of 3.646 million dollars, Figure 7 depicts that the amount received from Ghadan Fund is the most important variable with range of 3.701-3.593 million dollars while the amount received from bank is the second important variable that affecting the NPV with range of 3.680-3.612 million dollars. While Figure 8 indicates that the delay option is in the range of 1.23-1.42 million dollars with the risk average of 1.32 million dollars. With the given positive NPV and the risk level, the project should be accepted.

Figure 9: Net present value for scenario 5; Authors' estimate

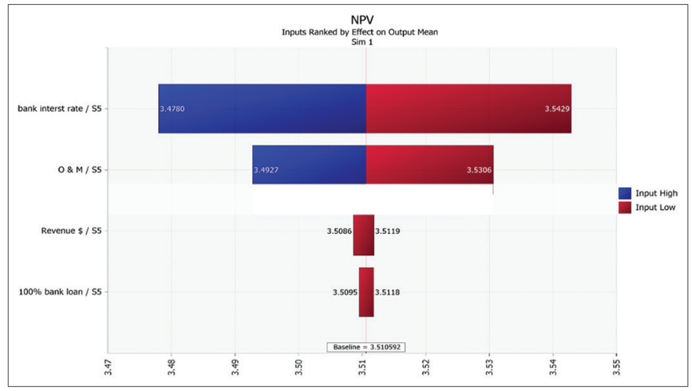
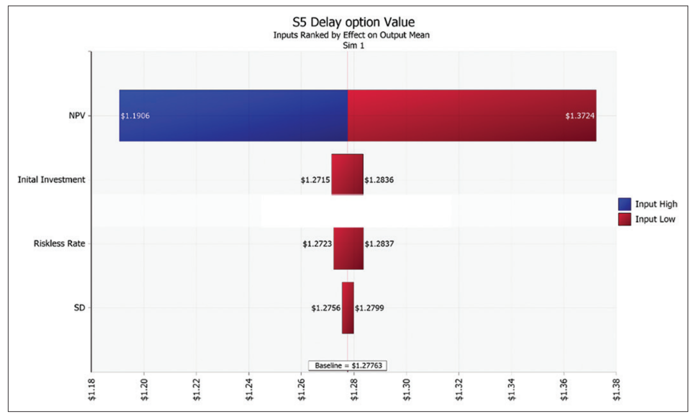


Figure 10: Delay option for scenario 5; Authors' estimate



4.5. Scenario 5 (100% Bank Borrowing with 10% Interest Rate)

In this scenario, we assumed that the project will be 100% financed by bank borrowing with 10% interest rate. The baseline is 3.510 million dollars. The most significant variable in this scenario as shown by Figure 9, is the bank interest rate as it has the highest NPV that could reach up to 3.5429 million dollars while the worst case can be reduced by 1.8% with 3.4780 million dollars. Operation and maintenance are the second important factor that affects the project in this scenario where it has the maximum NPV of 3.5306 million dollars as the best case and 3.4927million dollars as the worst case with percentage of 1%. While Figure 10 suggests that the option to delay could have a range of 1.19-1.37 million dollars with risk average of 1.27 million dollars and this is considered the lowest risk rate in comparison to other scenarios even with lowest NPV as well. Therefore, since NPV is positive, this scenario is considered as a good scenario.

5. IMPLICATIONS AND DISCUSSION

Our literature review suggests that many studies on the investment evaluation have predominantly used only the NPV to decide the

Table 3: Summery of NPV and *delay* option for each scenario

Scenarios	Initial investment ($)	NPV ($)	Value of option to delay ($)
S1-BAU 50% Ghadan Fund	56,966.06	4,322,496.56	1,573,836.64
S2-BAU 50% bank loan	56,966.06	4,187,433.77	1,524,149.82
S3-BAU 100% Ghadan fund	56,966.06	3,781,619.59	1,374,859.17
S4-BAU 50% bank loan and 50% Ghadan loan	56,966.06	3,646,126.18	1,325,013.95
S5-BAU 100% bank loan	56,966.06	3,510,446.47	1,275,100.20

NPV: Net present value

acceptance or rejection of the project. In this study, we used a more sophisticated, risk-oriented real option approach to reflect the implications of various scenarios. In addition, we used Monte Carlo simulation to forecast the future action of the project. By using five different scenarios reflecting the source of funds, we could come up with a clear picture whether investors should invest in an offshore wind farm in the UAE. Our results indicate that scenario 1 has the highest NPV with highest risk of delay option whereas the scenario 5 depicts the lowest NPV with the lowest risk of delay option. This result will have a policy implication that the investors or the SMEs would want to seek government support so that the high risk can be rewarded by high returns. Scenario 3 showed moderate NPV and moderate risk of delay option. Scenario 2 shows a good level of positive NPV but since the bank borrowing remains expensive, the delay option value does not get significantly lower. This could be a good alternative for the investors especially when the government support is not available. If we compare the risk of the delay options between the highest and the lowest scenarios, the difference is only 300,000 dollars. Will the investor be willing to take the risk and go for scenario 1 or be willing to play safe and go for scenario 5? This decision will demand further analysis of the factors that are associated with individual scenario. From economic perspective, although many studies have revealed that the cost of production of wind farms is reducing; there is risk of cost overruns due to external factors such as war, economic recession etc. Nevertheless, the growth in wind farms in the UAE will have a greater impact on energy sector. The more investors in this field will lead to more competition and create more flexibility on the cost and selling price of the electricity distribution in the country. As a result, there will be more employment opportunities in this sector. This has already been supported by Salim and Alsyouf (2020) and Alharbi and Csala (2021a) that the GCC region would see 220000 more jobs in in renewable energy field by 2030.

6. CONCLUSION

In this study, we try to bridge a significant literature gap by evaluating the investment in 6.1 MW floating bottom Fixed Wind Turbine to generate 2828800 KWh per year in the UAE. Our results clearly indicate that there are different factors which affect the NPV in each scenario. Although all the scenarios have positive NPVs; scenario 1, however, showed the highest potential with $4.3 million value with the highest risk in delay option of $1.6 million. Table 3 below presents the summary of all scenarios which makes it clear that scenario 5 has the least NPV of $3.5 million and $1.3 million delay option value. It is worth noting that the first two scenarios give the highest NPVs among all which is commensurate with the financial leverage theory that higher the risk, higher the returns. Surprisingly, scenarios 3 and 4 do not depict a significantly different picture both in NPV and option value terms while the fact is that the 50% bank financing mix is much more expensive. Considering all risk-return parameters, our study suggests that investors and SMEs have good fortune in investing in this wind farm sector. Further, investors can tap in variety of funding sources available in the UAE and benefit from this promising sector.

Our study deals with a very crucial business segment from economic contribution point of view and we used a much more sophisticated real option method with Monte Carlo simulation in order to gain some convincing insights. However, there have been some limitations. Firstly, our data estimation is based on US review report which may not reflect a 100% correct picture in the context of UAE. As this sector is in its infancy phase, not much information is either available or accessible. Secondly, some more scenarios based on different funding sources should have been used especially keeping in view the changing economic parameters in the UAE. Thirdly, financial assumptions should have regional perspective particularly the risk-free rate, default risk and risk premium. With this said, any future work around these stated points and the challenges facing offshore wind energy farm in UAE could generate further interest.

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