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Business Development of the Irreversible Investment for a New Energy Industry in Myanmar: Focused on Potential of SMART HOUSE

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Abstract: The energy has been a key in the progress of human society not only in Myanmar but also all over the world. Myanmar has considerable indigenous primary energy potential, which could meet domestic demand in long term if properly managed. Of course, some 80% of total population in Myanmar is still deprived of access to electricity. It is not right to live in the poor mire of energy-poverty in such a favorable situation of energy potential. Japan is the most developed nation, in my opinion, in management as to commercialization technique. For this reason, we will focus on potential of pioneering "Smart House" projects in Japan. My country, Myanmar, is a developing country, and needs technical managers in construction of our country to be developed nation. Simultaneously, Energy industry is one of the most capital intensive among high-tech industries. Moreover, strategic investment decisions involve a great deal of uncertainty in this dynamic and competitive environment. To capture the need for managerial flexibility is especially important when investments are in such an irreversible situation and under uncertainty. In this paper, we use a combination of real options and game theory to analyze the investment strategies for the start-up of high-risky energy industry. We propose the result to show strategic energy productivity in terms of cost-effective way for regional development and then, technical advances for the new project of Smart House from a perspective of ecology and quality of life.

Keywords: Sustainability, Smart House, Energy Industry, Option-Games, Business Development, and Regional Development.

1. Introduction

Myanmar is naturally endowed with both non-renewable and renewable energy sources. They are shown in Table 1and Figure 1. But they are so far to fulfill the energy requirements of the community; and much remains to be done in terms of research, experimentation and cost-benefit studies taking priority to the awareness of environmental impacts like pollution, deforestation, and so on. In this condition, technology investment is also important for the industrial development as a result of economic progress of Myanmar. Under the above grand view, I wish to focus on the potential of pioneering "Smart House" projects that are studied in some Japanese regions.

How is it possible to make irreversible investment in the project to launch an energy industry under uncertainty? How can technology investment optimize the trade-off between sustainability and economic development? How about the potential of smart house project to Myanmar as a country having later comer's advantage?

In order to cover the above all research questions, Real Options Analysis (ROA) should be employed to evaluate the economic validity of the innovative, promising, but high-risky project. At this point, the responsibilities as developing investment decision, resource allocation, innovation and switching a new option require a broad view by making analytical investigations. And game theory is also needed to analyze the cluster formation of players in new industry.

After examining original theory and approach for the start-up of energy industry from a new perspective of Japan's experimental and pioneering "Smart House" project, I wish to apply them to the practical condition in the country. And I propose the promising aspect after modifying the disadvantage of Myanmar. Besides, I also hope reliable, adequate and affordable energy supplies throughout the country for strong and sustainable overall economic growth in the long-run benefits and competitiveness to some extent.

Table1: Energy Resources in Myanmar as of 2008

No.	Description	Potential Reserve	Identified Reserve
1	Crude Oil (Offshore&Onshore)	15220.27 MMBBL	207.179 MMBBL
2	Natural Gas	93.698 TCF	12.617 TCF
3	Coal	711 MMT	310MMT
4	Hydro	108,000 MW	39,720 MW
5	Geothermal	93 Hot Spring	
6	Biomass	50.8%total land area covered with forest (344,234 km^2)	
7	Wind	365.1 TWH per year	
8	Solar Power	51973.8TWH per year	
9	Oil shale	5850 MMBBL	

MMBL = Million Barrels
MW = Megawatts
TCF = Trillion Cubic Feet
TWH=Terawatt Hours
MMT = Million Metric Tons
Source: Ministry of Energy, Myanmar Government

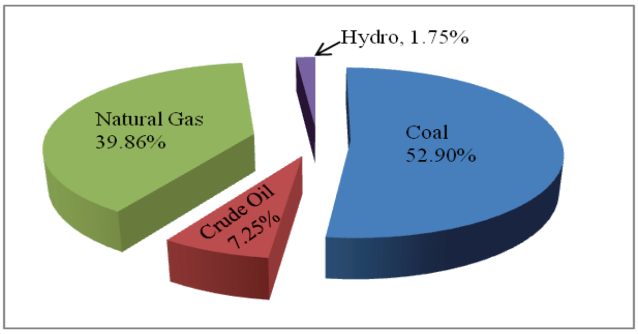

Figure 1: Identified reserve of Energy Resources (%)

2. Promise of Smart House in Future Energy Industry

In the uncertain and fiercely competitive high-tech industry, some of the most important decisions relate to investments in capital intensive equipment. The Energy industry for such kind of Smart House Project is characterized by intense technological and market competition. Companies must make huge capital investments with a corresponding high degree of risk because falling behind competitors means dropping out of the game. Rapid responses to competition and technology improvements are critical to success in this industry. This rush to get the latest-generation production facilities in high-tech energy industry is akin to an arms race, and therefore, capital investment for a start-up company is critical to the continuously success of firms.

Moreover, energy is very important to create a Smart Community, too. The Smart Community is a next-generation community in which management and optimized control of various control infrastructures such as electricity, water, transportation, logistics, medicine, and information are integrated. This can be seen in Photo 1. For the energy solutions, Smart Grid is the idea to stabilize the supply of energy through the optimal use of both conventional power systems and distributed generation - including renewable energy - and to coordinate power supply and consumption through bidirectional communication. To promote the more efficient use of electric power and to provide a variety of services, IT networks are utilized to obtain real time load information from homes, offices, and factories and other commercial establishments by forecasting demand and integrating various distributed power generation systems.

In Japan, the term "Smart House" refers to a new type of home that emphasizes reduced carbon emissions, increased energy efficiency, and the utilization of renewable energy sources. The renewable energy sources adopted in smart houses include fuel cells, solar cells, lithium-ion batteries and energy storage systems, and small wind turbines. It is shown in Photo 2.

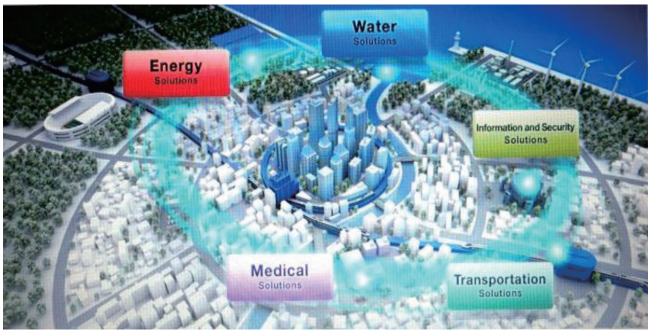

Photo 1: Smart Community *(Source: TOSHIBA-Smart Community)*

(Source: Sekisui House)

Photo 2: Smart House in Japan

3. Option-Games as Methodology

Investing in technology for the start-up of Smart House energy industry is a high-risky process that requires significant capital investment, and uncertainty plays a key role in decision-making. The traditional Net Present Value (NPV) rule is a static concept that fails to capture the need for managerial flexibility, which is especially important when investments are irreversible and involve a great deal of uncertainty. Moreover, the competition that characterizes the Smart House Energy industry requires a more comprehensive analysis of players' market strategies.

In contrast to NPV, options theory is based on the premise that the option holder has the right, but not the obligation, to exercise an option. Fundamentally, options theory (OT) offers a new and more realistic means of evaluating strategic opportunities and risks by hedging the downside risks and utilizing the upside chances that traditional valuation methods, such as the NPV approach, do not consider.

And, real-world investments are characterized by strategic competition between rival firms, where each firm assesses its own strategic competitiveness. Thus, Game Theory is an important management decision tool for studying strategies involving multiple players whose decisions are designed to maximize their own payoff or utility. In game theory, decisions made by each player impact the other players' utility gains. Therefore, game theory models can yield further insights into the investment process. Table 2 compares the NPV, options, and the game approach.

Table 2: Comparison between NPV, Option & Game

	NPV	Option	Game
Uncertainty type	Trivial	High	Interactive uncertainty
Minimal players	1	1	≥2
Strength	Intuitional	Consider uncertainty	Dynamic representation of uncertainty
Weakness	Fail to consider uncertainty	Complexity	Complexity

To sum up, the options method incorporates uncertainty when future volatility is contextually important. When the number of market players is more than 1, the interplay must be represented by the game approach, in which the payoff matrices are calculated by the options approach. The final monetary form of the payoff metric is represented by a discounted risk-adjusted NPV form.

4. Application of NPV, Option and Game to Strategic Investment

According to the NPV rule, an investment should be accepted if the NPV is positive and rejected if it is negative. NPV can be calculated as follows:

$$NPV = -I + \sum_{t=1}^{N} \frac{E(FCF_t)}{(1+k)^t}$$

Where, E (FCF) = expected free cash inflow
k = risk-adjusted rate
t = time point

For the real options method, the binomial model is formulated as follows:

$$C_0 = \frac{[pC_u + (1-p)C_d]}{1+r_f}$$

Where, C_0 = current option value
p = risk-neutral probabilities
q = actual probabilities
C_u = call value in up state
C_d = call value in down state
r_f = risk-free interest rate

Risk-neutral probabilities can be calculated as follows:

$$p = \frac{(1+r_f)-d}{u-d}$$

Where, u = up movement,
d = down movement

Strategic initiatives can no longer be looked at as standalone investments, but rather as links in a chain of interrelated, staged investment decisions. Moreover, if a firm's investment decisions are contingent upon and sensitive to competitor's moves, a more involved game-theoretic treatment might be necessary. Appropriate competitive strategies can still be analyzed using an integration of game theory with real options analysis.

4.1. Analyzing the One Stage Strategic Investment

This article introduces different aspects into our analysis with simple one-stage investment decisions under uncertainty, first when proprietary and then under competition.

4.1.1 Games against Nature: Under simple proprietary options

Assumption of Model

We assume the investment I=\$350 (in Million), volatility parameter σ=0.5, up or down with binomial parameter u=1.65 and d=0.61, risk-adjusted discounted rate k=0.25, risk-free interest rate r_f =0.08, actual probability q=0.5 and original project value v =500. If so, risk-neutral probability will be given:

$$p = \frac{(1+0.08)-0.61}{1.65-0.61} = 0.45, 1-p = 0.55$$

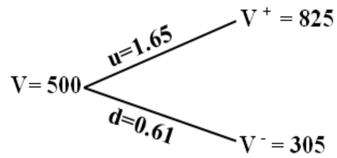

Figure 2: One Stage Development Game without managerial flexibility

At t = 1, $E(FCF_1) = (0.5 \times 825) + (0.5 \times 305) = 565$

The gross present value of the project is to be discounted at the opportunity cost of capital:

$$V_0 = \frac{565}{1+0.25} = 452$$

Invest now commitment value: NPV=-350+452=102 >0
It would lead to project acceptance.

With managerial flexibility to its original plans

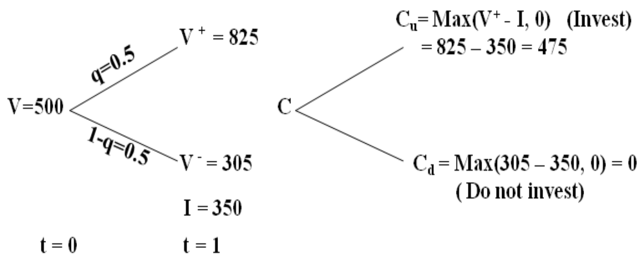

Figure 3: Proprietary Opportunity: Wait to Invest under Uncertainty

Current call option value (or) Opportunity to invest:

$$C_0 = \frac{(0.45 \times 475) + (0.55 \times 0)}{1 + 0.08} = 197.92 \simeq 198 > 102(NPV^*)$$

Above figure shows the managerial flexibility to defer investment for a year and invest if developments (e.g. demand or prices) are favorable (upward movement) or back out with limited loss (0) under unfavorable developments. In fact, such an investment opportunity will have a positive value, even if immediate investment commitment would generate a negative NPV because investment can be made only if the value of cash inflows, V, actually exceeds the required outlay I by a positive premium. Many investment opportunities with high barriers of entry for competitors are such kinds of proprietary real options. And the option to wait is valuable in the industries of high uncertainties, long investment horizons and limited competitive erosion.

However, in high-tech industries including energy industry, competitors can substantially influence a firm's investment opportunity. Increased competition may have an erosion effect on a growth option's value that may justify early investment. And when the type of investment invites a rival's response that in turn affects everyone's investment decisions and industry equilibrium production or pricing choices, a more involved game theoretic treatment is required. These will be discussed in next sections.

Shared real options can be used for the opportunity to introduce a new product impacted by introduction of close substitutes or to penetrate a new geographic market without barriers to competitive entry.

A. Impact of exogenous competitive entry: reduced option value (50% cash flow "dividends")

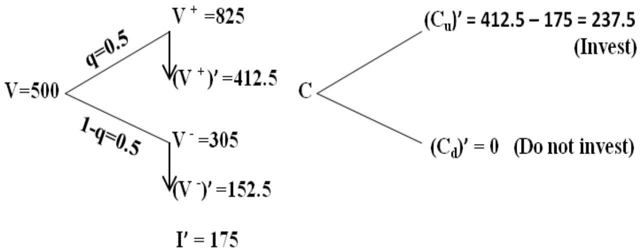

Figure 4: Shared Opportunity

Wait (present call option with dividends):

$$C_0' = \frac{(0.45 \times 237.5) + (0.55 \times 0)}{1 + 0.08} = 98.96 \simeq 99$$

B. Here, invest now/exercise early decision has superior effect of NPV to pre-empt competitive erosion or capture cash-flow "dividends" because its value 102 is greater than 99.

In one-stage investment options against nature, we distinguish the following effects:

The flexibility effect: arising from management's ability to wait to invest until demand develops sufficiently.

A competitive value erosion effect: presenting when exogenous competitive entry can take part of total market value away from the incumbent firm; viewed analogous to the impact of dividends (asset benefits) on a call option.

A pre-emptive commitment effect: arising when investing early can pre-empt anticipated competitive entry. The pre-emptive commitment effect must be weighed against the flexibility/learning value from waiting and forces rivals to invest early.

In high-tech industries, a firm may pre-empt competition and capture a significant share of the market by setting the product standard early on. Time-to-market may be an important source of advantage that may establish a sustainable strategic position for the organization.

4.1.2 Strategic Games against Competition

Analyzing Competitive Interactions

If each competitor's decisions depend on the other's moves, then a more involved game-theoretic treatment is necessary. Investing earlier than one otherwise to pre-empt anticipated competitive entry is a simple case of such strategic game against competition. Under the following four investment-timing scenarios, the resulting values either at the end of each tree branch or in the payoff table for firms A and B appear as follows:

(i) When both firms invest immediately and simultaneously they share equally the total NPV (½ × 102), resulting in a (51, 51) value payoff for each firm;

(ii)/ (iii) When one firm (A or B) invests first while the other waits and it pre-empts its competitor, appropriating the full NPV (102) for itself and resulting in a payoff of (102, 0) or (0, 102), respectively; and

(iv) When both firms decide to wait, they share equally the value of the defer option (½ ×198), resulting in a (99, 99) payoff.

These payoffs are shown in the table and figure below.

		Firm B	
		Wait	**Invest**
Firm A	**Wait**	(99, 99)	(0, 102)
	Invest	(102, 0)	**(51, 51)***

Table 3: Simultaneous Investment Timing Game Payoff (Prisoners' dilemma)

In the above value payoff structure, a Nash-equilibrium outcome is reached. It can be clearly seen firm A has a dominant strategy to invest, regardless of the timing decision of its competitor. Firm B also has a dominant strategy to invest, resulting in a Nash equilibrium (*) in the lower right cell, where both firms receive their second-worst payoff of (51, 51), an example of the well-known prisoners' dilemma.

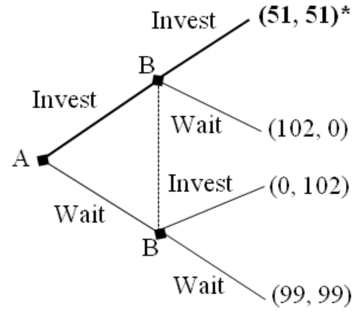

Figure 5: Decision Tree of premature competition and investment

The paradox, of course, is that the equilibrium outcome (51, 51) is worse for both firms, compared with the situation when both choose to defer, Pareto optimum (99, 99). If the two firms could co-ordinate their investment strategy they could share the flexibility benefits of the wait-and-see option, avoiding the inferior ''panic equilibrium'' where everybody rushes to invest prematurely.

5. Sensitivity Analysis

5.1 Analyzing the Impact on NPV When the Various Amounts of Investment Change

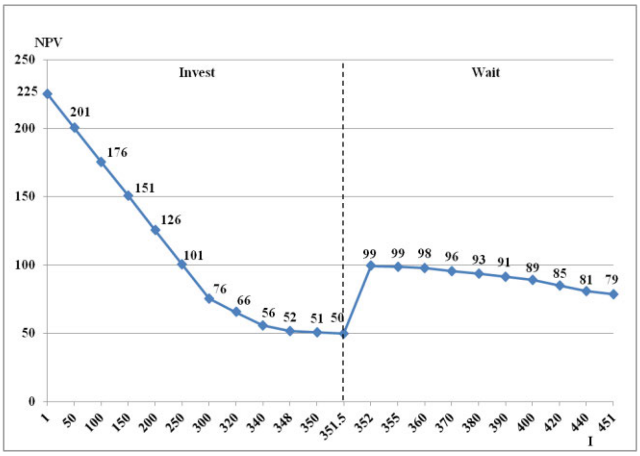

Figure 6: Impact on the NPV depending on the Investment movements

Above figure shows how to effect on the NPV whenever the investment amount changes. In figure, NPVs are the Nash-equilibrium values for both rival companies according to the Prisoners' Dilemma under the four investment-timing scenarios of Section 4.1.2. It can be clearly seen (both players') invest-now strategy has more favorable condition compared to (both players') wait strategy (deferral investment) at Nash-equilibrium except Pareto optimal strategies. And, it suggests that the companies should invest now until they reach the amount of $351.1(Million). Moreover, the smaller the investment is, the more NPV they will get. The slope of NPV gradually becomes steeper and steeper upwards with the small amount of investments.

On the other hand, over the amount of $351.5M the companies should defer their immediate investment. It means the companies must wait to invest if the amount is large. But, we can find that the NPV declines little by little together with the greater investments. In summary, it proves that it is not so good to invest too much under uncertainty according to the Prisoners' Dilemma.

5.2 Analyzing the Impact on NPV When the Investment Scale and Volatility Parameter change at the Same Time

Table 4: The Behavior of NPV Changes with the Shifts of Investment Amounts and Volatility

I / σ	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
1	200	201	204	209	216	225	237	251	267	286	308
50	175	176	179	184	191	201	212	226	242	262	284
100	150	151	154	159	166	176	187	201	217	237	259
150	125	126	129	134	141	151	162	176	192	212	234
200	100	101	104	109	116	126	137	151	167	186	209
250	75	76	79	84	91	101	112	126	142	162	184
300	50	51	54	59	66	76	87	101	117	137	159
301	50	111	111	56	66	75	87	101	117	136	158
305	48	109	109	57	64	73	85	99	114	134	156
310	45	107	107	54	61	71	82	96	112	132	153
320	40	102	102	102	56	66	77	91	107	127	149
340	30	93	93	93	94	56	67	81	97	117	139
348	26	89	89	89	92	52	63	77	93	113	135
350	25	88	88	88	91	51	62	76	92	112	134
352	24	87	87	87	91	99	61	75	91	111	133
355	23	86	86	86	90	99	60	74	90	109	131
360	20	83	83	83	89	98	57	71	87	107	129
370	15	79	79	79	87	96	105	66	82	102	124
380	10	74	74	76	84	93	103	61	77	97	119
390	5	69	69	73	82	91	101	56	73	92	114
400	0	65	65	71	80	89	99	108	68	87	107

Wait (pink) Invest (blue)

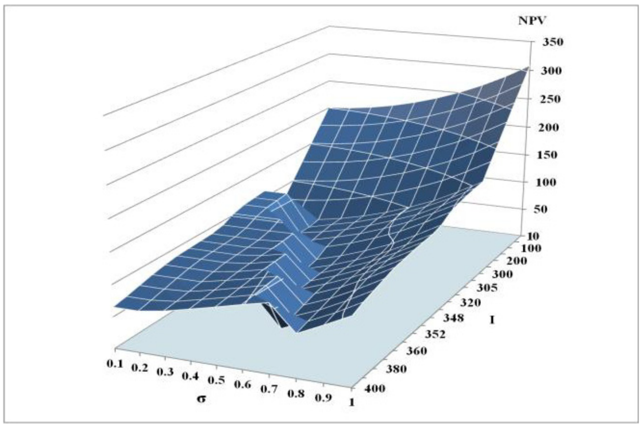

Figure 7: The Changing behavior of NPV depending on the shifts of two parameter values, I and σ

These Table 4 and Figure 7 bring out the result of NPV changes for both companies due to the dramatic movements of investment scale and volatility parameter. This analysis is also made under the well-known Prisoners' Dilemma. Thus, NPVs are Nash-equilibrium points for both sides. Under the range of volatility parameter 0 to 1, the investment scales are limited from the smallest amount of $1M to the largest one of $400M to protect against negative Nash-equilibrium NPV for any of the both companies.

According to the analysis result of NPV figures, it also reveals that the early investment is better than deferral one. As the same with previous analysis, too much investment is not a favorable situation for both sides at all. In addition, it is obviously pointed out the NPVs depend upon the increases in the volatility with the riskiness. In the Table, we can see the optimum NPV with the lowest investment of $1M and uppermost range of σ, 1. Additionally in the figure, the boundary diagonal line can be used as the index for Nash-equilibrium strategic shift between (Wait, Wait) and (Invest, Invest). This line expresses the evident relationship of Nash-equilibrium between risk and investment amount.

Finally, it can be generally drawn a conclusion that for a start-up company, the best way of investment decision is to practice the strategy of investing a little, but high riskiness with the rival firm to avoid the threat of entry within the dynamic technological and competitive environment. However, it should be noted that this analysis has neglected the changing of other parameter values such as risk-free rate and time to maturity and has no consideration of certain key inputs like the level of technical skill, market demand and the response manner of rival firm.

Nevertheless, above two quantitative analyses provide a treatment of important analytical considerations that are particularly relevant for executives facing high-stakes investment decisions.

6. Conclusion and Implication

In the new dynamic competitive landscape that high-tech and other industries are facing today, it becomes essential for firms to be more flexible in their investment programs, allowing management to change the amount, rate, timing or scale of investment in response to new, unexpected developments and competitive moves. The combined framework of real options and games approach to evaluating competitive strategies can help guide managerial judgment in deciding whether and when it is appropriate to grow locally or globally on its own, and which participation in a network or strategic alliance is the preferred route. But in the real world, implementing the option-games methodology and estimating the boundaries of certain key input parameters such as investment outlays in future opportunities and the level of technical and demand uncertainty, are subject to potential limitations. In addition, such option parameters as exercise price, firm-specific volatility or option maturity are likely to be idiosyncratic for each firm.

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