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Renewable energy business in oil companies - Case studies in Japan

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Summary

Renewable energy has been the top preference among new business domains of Japanese oil companies. Applying qualitative research method, the paper aims to analyse the practices of renewable energy projects in these companies, highlighting various influential factors on investment decisions in this field.

The fact is that five among seven Japanese oil companies choose at least one renewable energy sector as new business, including hydrogen stations, fuel cells, bio-fuel, biomass, solar energy, wind energy and geo-thermal. It is stakeholders concerned such as governmental agencies, consumers, users, suppliers, competitors, shareholders, investors, and employees that have impacts on a company's policies toward renewable energy. Especially, in Japanese oil companies, the important internal motivation is business transformation into total energy companies. Besides, national policies are the catalyst for renewable energy investment in most of the cases.

However, in order to retain the business, profits are the crucial element which could be granted through feed-in tariff (FIT) mechanism. Over the time, FIT, an economic instrument of the government, would be reduced as renewables become more cost competitive with traditional energy sources. In turn, companies' efforts to manage production cost and output quality as well as to enhance internal capacity or international co-operation would play a significant role in making renewable energy business become sustainable in the long run.

Key words: Renewable energy business, total energy companies, feed-in tariff (FIT), triple bottom line, Japanese oil companies.

1. Introduction

In the 21st century, noticeable fluctuation in crude oil prices and larger decline in this natural resource have been frequently observed. In the petroleum companies of which the business greatly depends on crude oil importation from overseas as in the case of Japanese oil companies or on crude oil exploration and production such as the Vietnam Oil and Gas Group (PVN), there has been an orientation toward renewable energy as the possible synergic options.

Based on available data, interviews and observations obtained from JCCP training course in 2017 together with recent public statistics and documents, we would analyse the best practices in the Japanese oil companies in terms of (i) identifying driving forces for renewable energy projects; (ii) determining whether or not renewable energy could be sustainable business. These might give some useful implications and reflections to PVN in the context of crude oil price changes and exhaustion of these stock resources, and the renewable energy business of PVN might be taken into consideration.

2. Theoretical framework

The most well-known concept of sustainability was first introduced in the Brundtland Report [1], stating that sustainable development is to meet the needs of the

Figure 1. *The triple bottom line [3].*

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Table 1. *Application of renewable energy [7]*

Solar	Power generation	Photovoltaic	Si, Ga-As, CIS, others
		Steam turbine	Tower
			Trough
		Updraft tower	
	Heat	Hot water, hot air	
Wind	Power generation	Mountain, land	
		Onshore	
		Offshore	Fixed-bottom floating
Biomass	Power generation	Direct combustion	
		Methane fermentation	
	Heat	Direct combustion	
		Methane fermentation	
	Transportation fuel	Bio-ethanol Bio-diesel, bio-aviation fuel	
Hydro	Power generation	Low heat hydro power	
Geothermal	Power generation	Binary turbine	Hot water
		Flush type	Steam
Snow & Ice	Cold energy		
Thermal energy conversion	Ocean	Binary turbine	
	River		
Underground heat	Air conditioning	Geothermal heat pump	
Ocean	Power generation	Wave, tide power, tide current	

present without compromising the ability of future generations to meet their own needs. Since that landmark record, there have been various definitions of sustainable development. The Organisation for Economic Co-operation and Development (OECD) presented the idea of developing in a way that benefits different sectors, across borders and even between generations. The central of sustainable development is to deal with three pillars together: society, economy and environment [2].

In the spectrum of sustainability, from the business point of view, the notion of the triple bottom line has been widely used. One is the traditional quantity of corporate profits. The second is the bottom line of people account, a measure in how socially responsible an organisation has been throughout its operations. The third is the line of the planet account, a degree of being environmentally friendly [4]. The triple bottom line captures the essence of sustainability by measuring the impact of an organisation's activities including both profitability, shareholder values and its social, human and environmental capital.

From the environmental science perspective, natural resources can be classified between stock and flow resources [5]. Whereas stock reserves such as plants, animal populations and mineral deposits, have the characteristic that today's use has implications for tomorrow's availability; flow resources, solar radiation, power of wind, of tides, of flowing water for instance, are naturally replenished, using more renewable resources today does not itself have any implications for the availability of those tomorrow. Renewable energy projects have some unique features besides the common characteristics of industrial projects. Although most forms of renewable energy are naturally available and cheap to operate, they are relatively expensive to install, as they have to take dispersed energy and concentrate it into a useful form. Regarding technology aspect, this often required the technical design feasibility of advanced technologies and adequate quality, preferably approved systems (i.e. following a defined standard). About the project site, an investor must be assured to have access to the site for construction and operation of facilities for the term of contracts. Another important feature is the off-take agreement, a PPA (Power Purchase Agreement) or other agreements including the terms of energy sale, and any other outputs of the project that generate funds [8].

The following section would study actual operating results of renewable energy projects in Japanese oil companies.

3. Analysis

The Japanese oil industry consists of seven private companies supplying around 50% of primary energy, relying on overseas resources mainly from the Middle East. In recent years, the industry faces significant competition

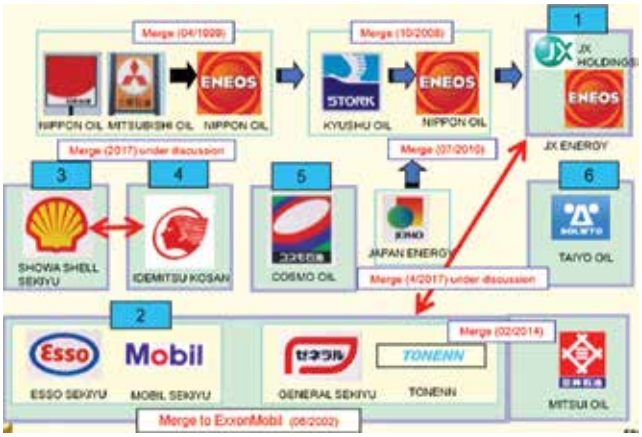

Figure 2. *Oil companies in Japan [9].*

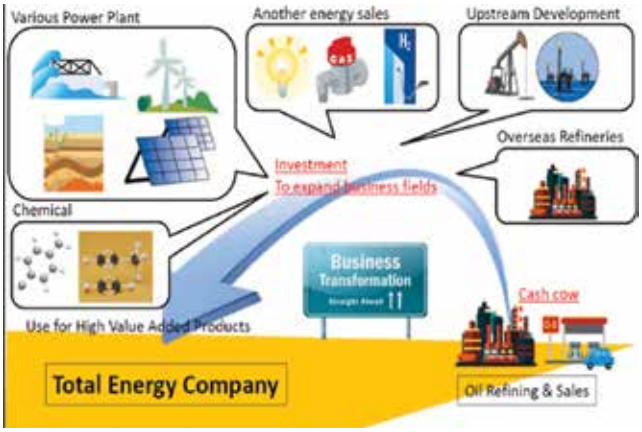

Figure 3. *Toward total energy companies [9].*

Table 2. *New business domains of Japanese oil companies [9]*

Company	Petrochemical	Crude Oil Exploration	IPP	EV Station	Hydrogen[1] Station	Bio Fuel	Fuel[2] Cell	Solar	Wind	LNG	Geothermal	Solvent	Specialty Chemical	Power Supply	Steam Supply	Electric Devices	Coal	GTL	Uranium Mining
JX	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y			Y	Y	
Idemitsu	Y	Y	Y	Y	Y	Y		Y	Y		Y	Y	Y	Y	Y	Y	Y		Y
Showa Shell	Y		Y	Y	Y		Y	Y		Y				Y	Y				
Cosmo	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						Y		Y	
Exxon Mobil	Y		Y									Y	Y						
Taiyo	Y	Y									Y								
Mitsui	Y	Y																	

Y Top runners Y Cooperating with national policies Y Doing business No business

and shrinking in the domestic oil market. Therefore, most of them have been seeking diversification and business transformation to be more efficient. The latest trend is to become total energy companies.

There have been six among nine renewable energy categories depicted in Table 1, occupying one third of new business domains of Japanese oil companies, including: 1. hydrogen station, 2. fuel cells, 3. bio-fuel, biomass, 4. solar energy, 5. wind energy, 6. geo-thermal. Five among seven companies choose at least one renewable energy sector as a new business. The below part reviews missions and strategies of these five oil companies about renewable energy.

3.1. JXTG Nippon Oil and Energy Corporation, "a comprehensive energy company, supplying various forms of energy to meet customers' need" [10]

Hydrogen stations, fuel cells:

- Hydrogen stations[3]: As of 31 July 2016, JXTG has operated 37 hydrogen stations in 9 prefectures of Japan, accounting for about half of all hydrogen stations in Japan.

- Fuel cells: JXTG has proposed a dedicated fuel for fuel cell vehicles, also focused on new business utilising in- house technology, SOENE house fuel cells with the target of 300 thousand cells to be sold per year [9].

Solar power: In 2016, JXTG operated 14 mega solar

[1]The Government of Japan and Tokyo Metropolitan Government have announced to showcase the potential of hydrogen to the world at the Tokyo 2020 Olympic and Paralympic Games. Thereafter they will spread the technology worldwide so as to promote a hydrogen - based society. [2]Fuel cells have high environmental compatibility that release no hazardous materials because power is generated by reaction between hydrogen and oxygen. [3]JXTG is a Tokyo 2020 Gold Partner to encourage fuel-cell vehicles (games official vehicles and buses connecting venues) and developing hydrogen supply systems in the Olympic Village (hydrogen stations, hydrogen pipelines).

power plants across Japan, with a total generating capacity of around 40 million kWh/year.

Bio-fuel

- Kawasaki Biomass Power Plant (28,000kW) of which power generated will be purchased by JX that leases the land for the plant [10].

- JX, IHI Corporation, and Denso Corporation formulated the Council to promote the growth of micro algae fuel in June 2012. A structure of 10 private companies, encompassing these 3 companies, will hasten the application of micro algae fuels by starting up an integrated production system for such fuels by 2020.

Wind power: In March 2005, JXTG opened wind generation facilities in Kashima Oil Refinery. These facilities produced 3,685 million kWh of electricity. However, it was the last wind turbine built by the group.

3.2. Idemitsu Kosan Co. Ltd. has been making efforts to "introduce renewable energy that has less impacts on the environment than conventional energy" [12]

Bio-fuel, biomass:

- Biofuel business: cultivating, securing feedstocks, producing, distributing and marketing fuel in Southeast Asia. Currently, Idemitsu is studying cassavas, palm oil in Indonesia, Malaysia and founded bioethanol business in Cambodia.

- Biomass power generation: Tosa Green Power Co. Ltd. with an output capacity of 6,250kW, 50% of its shares are held by Idemitsu. Fukui Green Power Co., Ltd. with an output capacity of 7,000kW, 10% of its shares are held by Idemitsu. Both are in operation.

Wind power: Jointly operating Futamata Wind Development Co., Ltd. with Japan Wind Development Co., Ltd., which is the first wind power plant combined battery in Japan.

Hydrogen: Joining phase 2 of JHFC[4] as a co-operative company; a commercial hydrogen station has been constructed at Narita Airport.

Geothermal:

- Since March 2017, setting up a 5MW geothermal power plant in Japan's south-western prefecture of Oita.

- Carrying out surveys in Amemasudake district of Hokkaido prefecture, Oyasu district of Akita prefecture, Bandai district of Fukushima prefecture

Solar power: Starting 3 solar power plants, namely "Moji" in Fukuoka prefecture in November 2013, "Himeji" in Hyogo prefecture in March 2014 and "Onahama" in Fukushima prefecture in November 2014.

3.3. Showa Shell Sekiyu Group's goal is to be "an energy solution provider supplying safe and sustainable energy" [13]

Solar power: The group began developing solar technologies since the oil crisis in the 1970s, containing crystalline and amorphous silicon. Then the group uncovered the advantages of CIS (Copper-Indium-Selenium) which were put in commercial production in 2007. Since this event, Atsugi Research Centre, a world-record-setting R&D facility, and a new production plant followed in 2009. By early 2011, the group had initiated the world's first gigawatt-scale CIS production facility and had been active in the global market.

Hydrogen stations, fuel cells: Participated in JHFC: (1) validated technologies to resolve issues: high-pressure recharging to extend cruising distances, quick refueling; (2) created initiatives to rationalise regulations on building hydrogen supply infrastructure. Since 2017, the Group and Idemitsu have been under negotiation for merging. As a result, they have loosen their mind in this sphere.

3.4. Cosmo Energy Holdings, "a vertically integrated global energy company, focuses on renewable energy to diversify the energy supply" [14]

Wind power: Since 2014, Cosmo Oil has become a head of shareholders of EcoPower (formed in 1997). It has power generation capacity of 184,000kW at its 22 areas, as of 31 March 2016, and ranks third in the domestic industry based on generation capacity. The group plans to expand business over the long term by broadening land-based sites together with participating in offshore projects. The Akita offshore wind farm project is a large-scale one led by the private sector. The total wind power generation capacity of Cosmo was expected to reach about 230,000kW in 2017.

Solar power: CSD Solar, which was established jointly with another company, had been steadily supplying power at 8 locations nationwide, as of July 2016.

[4]JHFC: Japan Hydrogen and Fuel Cell Demonstration Project, http://www.jari.or.jp/portals/0/jhfc/e/jhfc/index.html. [5]The first Fuel Cell Vehicles (FCVs) on the road with type IV tanks were the Toyota FCHV, Mercedes-Benz F-Cell and the GM HydroGen4.

Biofuel: In 2007 Japan's petroleum industry kicked off a demonstration project for trial sales of bio-gasoline, a regular gasoline mixed with bio-ETBE. The trial was expanded in 2008 to involve 100 service stations, enclosing 9 owned by Cosmo Oil. The company also conducted R&D in bioethanol and BTL (biomass to liquid). However, the group found biofuel not attractive right now because of high costs.

Hydrogen stations, fuel cells: As part of JHFC, Cosmo began operating Yokohama-Daikoku hydrogen station in 2002. In 2008, the group began the type IV hydrogen tanks for compressed hydrogen at 700 bars (70MPa; 10,000psi). In the stationary fuel cell business, based on the results of a demonstration project carried out in 2005, Cosmo intended to bring LPG fuel cell systems to the market in 2009. However, in 2013 the company closed its demonstration site of hydrogen station in Yokohama, along with the LPG fuel cell system.

Table 3. *Renewable laws and policies in Japan from 1995 to present, excluding hydraulic power*

In general	Energy policy is to ensure stable supply (Energy Security) at low cost by enhancing efficiency (Economic Efficiency) on the premise of Safety. It is also important to make efforts to pursue environment suitability (Environment) (3E + S)[16].
In 1995, the Electric Utilities Industry Law was revised to let corporations with electric generation capabilities sell electric power to utilities. In 2000, further revisions allowed direct sale of electricity to major users. In 2012, the Act on Purchase of Renewable Energy Sourced Electricity by Electric Utilities introduced a feed-in tariff (FIT) regime, by requiring electric utilities to purchase electricity generated from renewable energy sources based on a fixed-period contract with a fixed price. In 2015, the Government published a Long-term Energy Supply and Demand Outlook to present the ideal structure of energy supply and demand for 2030. Energy efficiency and renewable energy were expected to take an essential part. The Act on Special Measures Concerning Procurement of Renewable Energy Sourced Electricity by Electric Utilities (2011) promoted the use of renewable energy sources for electricity. The Act was amended on 03 June 2016, announcing a new certification system for FIT eligibility and a tender bid system for FIT, initially for large-scale solar projects [17].	
Incentive programmes for wind energy	The government has committed to the construction of a high voltage transmission network to help wind producers gain grid access. In 2016 and 2017: FIT and relaxed rules for onshore wind farms in harbours and ports have been proposed.
Incentive programmes for solar energy	In 2016, METI (Japanese Ministry of Economy, Trade and Industry) FIT pricing committee stated to reduce rates by 11.15% for over 10kW solar usage, which was a sign of tightening government budgets and a period of decreased incentives. To promote the use of photovoltaic cells in households, the Government offered installation cost subsidies.
Incentive programmes for biomass/bio-fuel	As for biofuel, which are mostly imported, the government continues the introduction of such fuel while taking into account international situation and technology trend concerning next-generation biofuel. For woody biomass power generation: increase biomass energy by pursuing scale merit and adopting mixed combustion at existing thermal power plants. It refers to regionally-distributed energy sources in addition to keeping up Japan's precious forests and vitalising forest industry [16].
Incentive programmes for hydrogen	1. Japan Hydrogen and Fuel Cell Demonstration Project - JHFC (supported by METI): Objectives of phase 1 (2002 - 2005): (i) clarified the high energy efficiency of FCV; (ii) defined "Well to Wheel" efficiency: from the mining of the primary energy, production, transportation and filling, driving vehicles with demonstration data of FCVs and hydrogen stations. Objectives of phase 2 (2006 - 2010): (i) resolved issues in practices; (ii) set up regulations, codes, standards; (iii) public relations, dissemination, promotion; (iv) verified energy saving (fuel economy) and environmental impacts; (v) determined technology, policy trends of FCVs, small fuel-cell powered vehicles and hydrogen engine vehicles with hydrogen infrastructures. 2. Strategic Roadmap for Hydrogen and Fuel Cells (2014) of METI has set a target to build around 160 hydrogen stations by the year 2020 [18]: Phase 1: expand the applications for fuel cell technology (fuel cells for households, FCVs), target to achieve dramatic energy conservation plus acquire a new global market (scheduled to begin in 2014). Phase 2: create a system for supplying hydrogen using unconventional energy resources imported from other countries. At the same time enhance energy security measures, full-fledged introduction of hydrogen power generation (time frame: putting the technology into practice by the late 2020s). Phase 3: organise a carbon-dioxide-free hydrogen supply system using renewable and other energy (time frame: putting the technology into practice around 2040).
Incentive programmes for geo-thermal	Geothermal energy is expected to increase to 1.0 - 1.1% of primary energy by 2030 [19]. METI is considering 36 geothermal projects in addition to the 537MW of capacity at the 17 facilities which currently exist. Moreover, METI is targeting to raise geothermal capacity by another 50MW by 2020. The FIT was also suggested in 2012 to accelerate geothermal power [17].

3.5. Mitsui has been working on geothermal energy by leveraging their experiences in E&P

The company has begun the business by conducting a joint survey in Hokkaido and Akita prefecture in 2012. At present, it has participated in 5 projects in Hokkaido and Tohoku area. Among these, for the Matsuo-Hachimantai Project in Iwate prefecture, the company decided to move to the development phase in February 2017 and constructed a geo-thermal power plant [15].

In order to explore Japanese oil companies' motivations into renewable energy, a preview of legal documents since 1995 has been made as in Tables 3 and 4.

We can see that each company has its own motivations which fall into three categories as noticed in Table 2: (i) co-operating with national policies, (ii) doing business or (iii) private options.

Regarding hydrogen and fuel cells, four companies have complied with JHFC: JXTG is the top runner, consistently expands hydrogen supply business (advancement of small size and highly efficient hydrogen production equipment using petroleum-based fuels such as LPG, naphtha and kerosene). Moreover, the group founded the ENEOS Hydrogen Trust Fund in 2006 (with the initial contribution of USD 14 million) for innovative and pioneering research. Each year this fund provides up to USD 500 thousand or USD 900 thousand per project. Idemitsu joined phase 2 of JHFC as a co-operative company, building one hydrogen station. While Showa Shell is not interested in this field anymore and Cosmo closed the demonstration site in 2013. The reasons are that hydrogen stations are considerably expensive and that lack of demand (expansion of fuel cell cars) restricts investment in building hydrogen stations. Currently, only 101 hydrogen stations are in operation among 34,000 gas stations.

Considering bio-fuel, Idemitsu takes the lead in feedstocks, production, distribution and marketing in Southeast Asia. Whereas JXTG has involved through leasing the land for the biomass power plant, and been at the initial stage of producing algae. From Cosmo's perspective, biofuel is not attractive right now because of high costs.

On the other hand, there are four companies doing well with solar power generation. Since the FIT system was launched in 2012, Idemitsu has been running three solar power plants. JXTG has been actively engaged in the mega solar power generation business using its idle lands. It has been developing next-generation CIS thin-film solar cell technologies and manufacturing solar panels with the total production capacity of more than 1,000MW per year. Solar Frontier (a subsidiary of Showa Shell) provides solar energy solutions and sells the CIS panels all over the world (Europe, the U.S, the Middle East, and Asia). Showa Shell's ambition is to become not only a mega solar operator, but also a global PV panel supplier. Cosmo recognises mega solar power generation as part of their green power business.

Concerning wind power generation, Cosmo is the pioneer, steadily running power generation facilities and achieving higher earnings over time. Wind power is another zone of Idemitsu green power whilst JXTG has not operated any wind turbine since the last one in Kashima refinery.

Last but not least, about geothermal, Mitsui Oil Exploration Co., Ltd. has been in partnership with Idemitsu Kosan Co. Ltd. to pursue commercialisation studies on geothermal power generation since 2011. The current project of Idemitsu in Oita (5MW geothermal power plant) will be one of the largest binary power plants in Japan.

In summary, it is obvious that Japanese oil companies' strong commitments to the environment and society

Table 4. *Tariffs for solar PV, wind power, geothermal power [20]*

		Solar PV		Wind power		Geothermal power	
Procurement category		≥ 10kW	< 10kW (purchase of excess electricity)	≥ 20kW	< 20kW	≥ 15,000kW	< 15,000kW
Costs	Installation cost (USD/kW)	2,593	3,954	2,778	11,574	7,315	11,389
	O&M costs (USD/kW/year)	83.4	39.8	55.6	-	305.6	444.4
Pre-tax IRR		6%	3.2%	8%	1.8%	13%	
Procurement price/kWh	Tax inclusive (UScent/kWh)	36	38	22	55	18.6	40
	Tax exclusive (UScent/kWh)	33.3	35.2	20.4	51	24	37
Duration		20 years	10 years	20 years	20 years	15 years	15 years

could be defined as one of the first driving forces toward renewable energy. Besides, national policies are the catalyst for renewable energy investment. However, in order to retain the business, returns are the crucial element.

4. Discussion

This section focuses on the driving forces toward renewable energy and discusses to what extent renewable energy could be sustainable business.

4.1. From the government point of view, in 2016, Japan ratified UNFCCC-Paris Agreements, aiming to attain a reduction of 26% in greenhouse gas emissions. It is global trends, international treaties which are driving renewable energy policies forward. In Japan, social attention is another influential factor. Prior to the Fukushima nuclear accident (initiated primarily by the Tsunami following the Tōhoku earthquake in 2011), nuclear power generated approximately 30% of Japan's energy. Since the disaster, almost all Japan's nuclear power stations have been switched off due to people's concerns and there have been unprecedented renewable energy opportunities in Japan [17].

From the company aspect, stakeholders such as political and governmental affairs, consumers, users, suppliers, competitors, shareholders, investors, and employees have vital influences on the company's policies. Companies run for profits (as desired by shareholders, investors, etc.) at the same time make great efforts for environmental protection (as expected by the government, consumers for instance). Particularly in Japanese oil companies, conserving nature is set as their own mission to fulfill. The other internal motivation of Japanese oil companies is business transformation toward total energy companies and renewable energy is top consideration among their new business domains.

Moreover, it is essential to emphasise that in most Japanese oil companies, the key making changes happen in investment for renewable energy is profits which are mostly effected by FIT. This is an instrument of governments to provide renewable energy producers long-term contracts to purchase energy at a set price, normally based on the cost of production plus an additional incentive. The approach actually have two different offers: (1) providing a price high enough to promote the desired investment; (2) guaranteeing the stability of that price rather than forcing investors to face market uncertainties [6]. The "well-adapted feed in tariff regimes are generally the most efficient and effective support schemes for promoting renewable electricity" [21]. In Japan, for instance, the share of renewable electricity, which was 9% in 2011, has increased to 15% in 2016 (Figure 4), due to the enforcement of the FIT Act (2012). Accordingly, renewable energy has become the third largest energy source after liquefied natural gas (LNG) and coal. In fact, the FIT Act has opened new perspectives toward making renewable energy the main energy source in Japan [16].

4.2. The second question of whether or not renewable energy could be profitable business and sustainability would be tough to clarify. Except the case of hydrogen and fuel cells which are in the R&D and pilot stage, the others have already been in the commercial scale, facing certain obstacles:

Financial challenges: In Japan, at the moment, the country has one of the most generous FIT schemes in the word [17]. For example, the tax exclusive procurement price is 20.4 cents/kWh for wind power projects with the capacity above 20kW or 51 cents/kWh for wind power capacity below 20kW (Table 4). However, this tariff would be decreased as renewables become more cost competitive with traditional energy sources. Consequently, dramatic change in the market is predicted as illustrated in Figure 5.

Technical challenges associated with the penetration

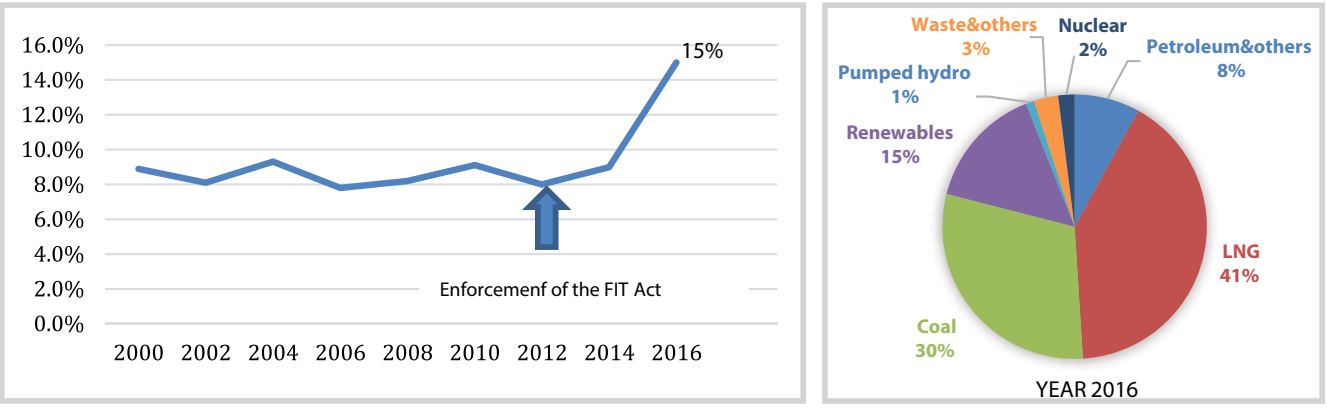

Figure 4. *Changes in the share of renewable energy in total electricity generated and purchased in Japan before and after the FIT Act [11].*

of renewable energy sources such as wind power are (i) lack of frequency regulation capacity, (ii) production of surplus power, (iii) increase in system voltage, (iv) insufficiency of available transmission capacity [22].

Site challenges: in the case of Cosmo wind power projects, the company had to go through 12 procedures and 11 related laws[6]. In the situation of geothermal, nearly 80% of Japan's geothermal resources are located within national parks or protected hot springs, designated restricted zones with limits on types and locations of work that can be done. It is strict regulations, complicated environmental impact assessments and zoning restrictions that continue to be barriers for geothermal power.

Overcoming these challenges is the necessity, but not the warranty for renewable energy to be sustainable business.

The companies could expect more incentives from the government, requesting FIT to be increased. However, for the time being, the overall trend for FIT as mentioned above is intended to be reduced as renewables become more cost competitive with traditional energy sources [21]. Alternatively, efforts from the company itself to reduce the costs are prerequisite. Cost reduction together with supports from the government would maximise companies' margins. For example, despite the fact that Japan is ranked first on the International Trade Administration list of top solar export markets in 2016, it has encountered increasing competition from Chinese manufacturers [17]. The oil companies doing business in this sector like JXTG, Showa Shell, Cosmo, and Idemitsu might need to reform in order to adapt in the competitive overseas market as well as changes in national policies (In 2016, METI FIT pricing committee stated to reduce rates by 11.15% for over 10kW solar usage, which was a sign of tightening government budgets and a period of decreased incentives, Table 3).

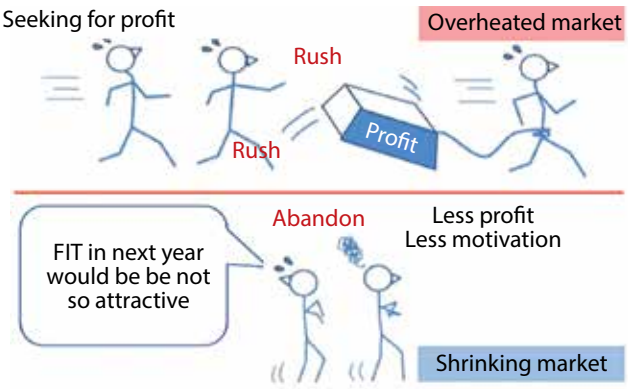

Figure 5. *Basic image of FIT [7].*

4.3. Further analysis in the best practices in Japanese oil companies would give some implications and reflections to PVN

In terms of cost management in renewable energy projects, in Cosmo's wind power projects for instance, all stages of development, EPC, power generation and O&M are carried out within the group. Some would suggest PVN utilise its own capacity in every stage of projects, or localise equipment and technologies. However, it might be not feasible because it is difficult for a Vietnamese company to manufacture all equipment while the local market is not big enough or it is not easy to self-implement in every phase of a project when internal factors and options for improvement are limited.

Referring to starting up a new business, it does take time. Showa Shell Sekiyu Group began developing solar technologies since the 1970s and had first commercial production 37 years later (2007). Also, in the 1970s, Idemitsu has involved in geothermal resources. After 26 years, in 1996 it began supplying geothermal steam to Kyushu Electric Power Co. Inc.'s Takigami Power Plant in Oita Prefecture. More than 10 years ago, so as to boost the hydrogen-based society and fuel cell industry, the Japanese government launched the demonstration project (JHFC), encouraging oil companies to participate. Since then, JXTG has been the top runner with the Hydrogen

6

Procedures to Japanese Government	*Related Japanese Laws*
Notification of land transaction	*National Land Planning Act*
Application for development permission	*City Planning Act*
Application for permission of diversion of agricultural land	*Agricultural Land Law*
Application for forest land development	*Forest Law*
Notification of deforestation and reforestation	*Forest Law*
Notification of civil engineering works of the land (archaeological culture asset)	*Law for the Protection of Cultural Properties*
Notification of change of the land character	*Soil Contamination Countermeasures Act*
Application for permission of new structure construction	*National Park Law*
Application for permission of structure installation in the riverside area	*River Law*
Environmental impact assessment	*Environmental Impact Assessment Law*
Necessary procedure pertaining to other laws	*Radio Law*
Necessary procedure pertaining to other laws	*Aviation Law*

Trust Fund for innovative research and gradually grew hydrogen supply business.

Other companies which did not have an early start, choose to collaborate with the pioneers. Cosmo, in 2014, has been a head of shareholders (89% share) of EcoPower (formed in 1997), ranking third in the domestic wind electricity industry. Mitsui, in 2012, has co-operated with Idemitsu in geo-thermal energy.

Some companies are taking their own advantages or experiences to start renewable energy business. For instance, JXTG is utilising technologies and know-how of petroleum refining to produce small size, highly efficient hydrogen production equipment using petroleum-based fuel. Whereas, Mitsui has been jointly working on geothermal energy by employing experiences in E&P.

These are some practical lessons which could be drawn for PVN, in terms of project management, internal capacity improvement, advantage ultilisation or international co-operation on the roadmap toward renewable energy business.

5. Conclusion

Case studies of oil companies from Japan have revealed the fact that renewable energy business has spread as a prevailing tendency but the speed substantially depends on the philosophy of each country, technology innovation and business models targeted by the companies. FIT, an economic instrument of the government is recognised as the most influential agent. In Japan, 9% share of renewable electricity in 2011 has risen to 15% in 2016, due to the enforcement of the FIT Act (2012). However, FIT would be reduced as renewables become more cost competitive with traditional energy sources. It is companies' efforts to manage production costs, output quality, enhance internal capacity that can play a significant role in making renewable energy business become sustainable in the long run.

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