The impact of energy transition on sustainable supply chain management of oil and gas: A content analysis of corporate sustainability reports

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0508
The Asian Conference on Sustainability, Energy and the Environment 2013
Official Conference Proceedings 2013

Abstract
Concerns over environmental impact of oil and gas (O&G) and its future availability have resulted in increased call for transition to low carbon energy. Although various studies have been conducted on energy transition, few researchers studied the impact of the transition to O&G supply chain. Since O&G is one of the primary sources of energy, it is important to examine how the transition is impacting its operations. The issue here is not only about the sustainability of its supply chain, but also how O&G industry can remain resilient against changes in its environment and its compatibility to sustainable future. Therefore, a content analysis of sustainability reports of 30 O&G companies was conducted to identify the impact of the energy transition on O&G supply chains and how the issue is addressed by the companies. The analysis revealed that there are two types of transition currently happening in the industry – transition to (1) unconventional O&G and (2) alternative energy. While the industry is supportive to the development of alternative energy, 60% of the companies are involved in research and development of green technologies, it is also apparent that their main focus is on the development of unconventional O&G. In addition, increased efforts are being concentrated on improving efficiency of operations and products, which could help in addressing sustainability issues especially in terms of carbon emission reduction. Overall, it was found that the O&G companies seek for opportunities in alternative energy development that create synergies with their current business and areas of operations.

Keywords: energy transition, supply chain management, oil and gas, sustainable development

1 Introduction

The O&G industry plays a major role in driving economic and social growth. According to the Energy Outlook 2030 (Bp, 2011), the world primary energy consumption will grow for about 39% over the next 20 years. Even though the percentage of O&G in the future energy mix is predicted to be lower, these fuels combined will remain one of the most important sources of energy for decades to come. However, concerns over the environmental impact of O&G and the move towards low carbon economy have encouraged the development of renewable energy as its substitute. Even though the evolution process from high carbon to low carbon energy is currently very slow (Jiping, 2010), studies should be done to identify how the shift will affect the supply chain of oil and gas.

A lot of O&G companies had diversified into renewable energy business to address the issues of energy transition and increased pressure for sustainable practices. However, the impact of these moves on their sustainable supply chain management practices hardly received any attention. This gap should be addressed so as to identify the strategic and structural changes in the management of the O&G companies' supply chain due to the diversification. Therefore, this study aims to explore the impact of energy transition on sustainable supply chain management of O&G by conducting a content analysis of sustainability reports of 30 O&G companies. The following questions are addressed in this study:

1. To what extent is energy transition being discussed in sustainability report of O&G companies?
2. What are the types of energy currently being developed by the companies?
3. What are the impacts of the development to the companies supply chain management?

The outline of this paper is as follows. In Section 2, a review of literature is discussed. The methodology used in this research is presented in Section 3. Then, the result is discussed in Section 4. Finally, conclusions and recommendations for future research are presented in Section 5.

2 Literature review

Sustainable supply chain management is defined as "the strategic, transparent integration and achievement of an organization's social, environmental and economic goals in the systemic coordination of key organizational business processes for improving the long-term economic performance of the individual company and its supply chains" (Carter and Rogers, 2008). There are two keywords in the definition which are especially relevant to this study about the impact of energy transition on O&G industry – strategic and long-term.

Achieving more sustainable supply chain is not only important in ensuring that the O&G industry could contribute towards sustainable development, but most importantly its ability to sustain itself in the future. Carter and Rogers (2008) stress that it is socially irresponsible for a company to undertake social and environmental goals of sustainable supply chain management without considering the broader context of the company's strategic and financial goals. Taking this view into consideration, by making a transition to include alternative or renewable energy to its

business portfolio, the O&G industry will not only be able to green its supply chain but also ensure that the industry can still remain in business in the future.

2.1 The oil and gas supply chain

The O&G supply chain comprises of companies that can be categorized as operators (oil companies), main contractors, sub-contractors and suppliers (Anderson, 2003). There are two industrial segments in the O&G supply chain – upstream and downstream. The upsteam segment which is also known as exploration and production (E&P) finds and produces crude oil and natural gas from onshore and offshore production fields. The output of exploration and production activities is used by downstream segment to produce and market various refined petroleum products for domestic and business consumers.

The O&G industry is facing increased difficulty in finding and developing new sources of fuels. This is because increasing reserves of O&G constitute of unconventional sources which are located in difficult environment such as tight rock, deepwater and the arctic which are costly to be developed (Kjärstad and Johnsson, 2009; Edwards *et al.*, 2010). The difficult environment and different types of sources require changes in the production processes as well as distribution and logistics system (Edwards *et al.*, 2010). Concerns about future availability of O&G have resulted in increased calls for transition to low carbon energy systems.

Edwards et al. (2010) note that the emergence of alternative energy is expected to have an impact on O&G companies in the future. According to Exxonmobil (2010), there are three factors that will shape future energy trends which are expansion, evolution and efficiency. The development of technology that enable environmentally responsible energy production will determine the ability of energy sector to expand all energy sources to meet demand and the efficiency of the fuels produced. A lot of O&G companies are transitioning itself into energy companies by investing in alternative energy development such as biofuel, wind and solar. Little is known about the impact of these 'transition' on O&G companies and their sustainable supply chain management strategy.

2.2 Energy transition

According to Smil (2008), *energy transition* "encompass the time that elapses between an introduction of a new primary energy source (oil, nuclear electricity, wind captured by large turbines) and its rise to claiming a substantial share (20 percent to 30 percent) of the overall market, or even to becoming the single largest contributor or an absolute leader (with more than 50 percent) in national or global energy supply". It is also a term that refers to the gradual diffusion of the technology used to generate and deliver energy for household, industrial, and transportation use (Smil, 2008).

An oil transition is currently happening in the O&G industry – transition from conventional to unconventional sources. Farrell and Brandt (2006) suggest that oil transition is not a transition from abundant to scarce sources of oil. It is rather a transition to high quality to lower quality resources that simultaneously caused increased risks to the environment, as well as economic and strategic risks to O&G industry operations (Farrell and Brandt, 2006). They stress that the main challenge in

the oil transition is to simultaneously manage these risks: (1) the risks of environmental damage, (2) economic risks to consumers and investors, and (3) strategic risks associated with access to oil reserves and supply disruption.

According to multi-level perspectives of transition, the sociotechnical landscape of energy systems comprise of material and immaterial elements at macro level in which regimes and special niches exist (Kemp, 2010). The regime of energy system is dominated by fossil fuels which have been used to power the industrial and societal growth since the early 20th century. However, the regime – fossil fuel industry – is currently under pressure by the 'landscape' especially from the political forces, regulations, and society to operate sustainably. In addition, the regime is also experiencing uncertainty in their business as a result of economic instability and uncertain future availability of fossil fuels. Therefore, these factors have resulted in an 'opening' in the regime that encouraged the development of niches of alternative technology namely renewable energy.

The renewable energy accounts for about 3% of primary energy consumption in the world with major sources are from hydropower, geothermal and wind (Lior, 2010). According to Fouquet (2010), the opportunities to produce cheaper or better energy service are the main economic drivers for energy transition. In the case of transition to low carbon energy, cheaper renewable energy can be produced because its feedstock can be obtained from various sources which are abundantly available such as solar, wind, and plants. In addition, it also provides better energy service in terms of its carbon emission. The renewable energy is expected to grow at 8.2% per annum in the next two decades (Bp, 2011). However, until considerable progress is made to the renewable energy technology, its potential is limited. Currently, the renewable energy development is very slow and cost intensive since the technology used is fairly new (Lior, 2010). In addition, the viability of renewable energy supply in the long run is questioned because of various factors associated with the availability of its feedstock (Stoeglehner and Narodoslawsky, 2009; Lior, 2010; Mu *et al.*, 2011).

As one of the major players in energy sector, the O&G industry will be affected by the energy transition (Edwards *et al.*, 2010). They can either continue doing what they do best – exploring and producing O&G – but risk running out of business in the long run (Savitz and Weber, 2007); or involve in the so called cleaner energy race to remain resilient against the changes in their business environment. Fouquet (2010) notes that while it is too early and complex to identify the strategies that fossil fuel supply companies will develop to respond to the energy transition, the companies can be expected to ensure that they become more competitive and harder to be replaced. Their responses to the transition process "will probably be on a scale unprecedented in the history of energy transitions" (Fouquet, 2010).

A lot of O&G companies are involved in the development of alternative energy. It is interesting to study the impact of this move to their supply chain management strategy as they strive to operate more sustainably. Since every type of energy is different, it is important to identify the changes that the companies have to make in the management of their supply chain. To the best of our knowledge, there is a lack of research on sustainable supply chain management practices in energy transition. Literature on energy transition can generally be categorized into three areas of research namely (1) history of energy transition, (2) transition management, and (3) transition in oil and gas energy systems. Major focus of energy transition studies is concentrated on the

transition management to alternative energy or its variants – transition to low carbon economy or sustainable energy. This study, therefore, aims to add to the discussion on sustainable supply chain management aspects of energy transition by exploring this issue through content analysis of sustainability reports of O&G companies.

3 Methodology

This study used content analysis method to answer the questions listed in the introduction. Data were collected from sustainability reports of 30 O&G companies through keywords search. Sustainability reports offer rich source of secondary data that could help us understand how sustainability is being addressed by companies (Tate *et al.*, 2010). Secondary data sources are also useful in understanding logistics and supply chain phenomena, that could result in more practical managerial relevant applications especially when the data are collected from the field (Rabinovich and Cheon, 2011).

The companies selected for this study were identified using three listings: (1) 2011 Dow Jones Sustainability Index, (2) Platts top 250 global energy company ranking 2011, and (3) O&G Journal's World's largest O&G company ranking. The listings were used so that the companies selected comprises of those which are among the best in the industry in terms of sustainability and/or financial performance, and also among the largest O&G company in the world – some companies are listed in more than one listing.

Table 2: List of companies selected according to listings

	Dow Jones Sustainability Index	Platts Top 250 Global Energy Company	World's Largest O&G Company
Company name	Repsol, Petrobras, Ecopetrol, BG Group, Eni, Statoil, Total		
	MOL, Sasol		
		Hess, Exxon Mobil, BP, Shell, Occidental, Gazprom, Chevron, Rosneft, Lukoil, PetroChina, Suncor	
		CNPC, TNK-BP, Marathon Oil, Gazprom Neft, OMV, Husky Energy and Galp Energia	Saudi Aramco, ADNOC and Petronas

Purposive sampling method was used to select 30 companies that published sustainability or corporate responsibility report. The companies selected are as shown in Table 2. The latest report available was used in this study – the reports are from 2009 (two companies), 2010 (25 companies), and 2011 (three companies).

Table 3: Keywords used in this study

Topic	Keyword
Energy transition	Transition, shift, energy transition, diversify/ diversification,
Types of energy	(Un)conventional, renewable, alternative, new energy
(Un)conventional oil and gas	Oil, petroleum, natural gas, shale oil/gas, tight gas, coal seam gas, coalbed methane, heavy oil, oil/tar sands, bitumen
Renewable / alternative energy	Biofuel, biomass, biogas, solar, wind, geothermal, nuclear, hydro,
Sustainable supply chain	Supply chain, network, transport, distribution, logistics, supplier, production

Data were collected from the sustainability reports using keywords listed in Table 3. Statements or sentences related to the keywords listed were gathered and categorized according to its topic category. They were analyzed to identify patterns in the discussion about the energy transition and sustainable supply chain management practices. The results are discussed in the following section.

4 Results and discussions

The results of this study are discussed according to the questions stated earlier in the introduction.

4.1 Extent of energy transition discussions in sustainability report of oil and gas companies.

Review of sustainability reports of companies selected in this study indicates that energy transition is an issue that attracts considerable interest from the O&G companies. About 37% of the companies mentioned energy transition explicitly in their reports. Generally, the discussions among these companies revolved around the following issues: (1) challenges and opportunities of energy transition, (2) strategy in dealing with the transition, and (3) the role of natural gas in the transitional phase towards low carbon energy systems.

The energy transition presents both challenges and opportunities to O&G companies (Hess, 2011; Mol, 2011; Sasol, 2011; Suncor, 2011). Demand for energy is growing especially from developing countries due to increased economic activities and improved standard of living. However, energy options which are favored for its economic and political appeal may not be environmentally sustainable and vice versa. Therefore, a balanced approach towards transitioning the energy systems to lower-carbon sources is required. Sasol believes that urgent developmental needs of emerging economies must be considered when making the transition (Sasol, 2011). This is to ensure that the transition is not disruptive to economic and social development, while necessary steps are also taken to reduce the impact of energy development and use to the environment. Integrated public policies that consider the contextual environment of the regions in which they apply are needed to address this issue (Sasol, 2011).

The O&G companies are also concerned about the risks that could result from legislative and regulatory requirements on issues related to the transition such as carbon emissions reduction (Bg, 2011; Hess, 2011; Repsol, 2011). Sector-based regulations being developed by governments could cause regulatory and compliance risk. This may lead to changes in technical and trade requirements in the O&G supply chain. It can also increase operating cost and reduce the industry's competitiveness. The biggest challenge of all is that the national and regional regulatory measures and international agreements to minimize emissions are evolving at different phase and timing (Petrobras, 2011). It is therefore difficult to predict its business impact and could discourage investment in necessary energy and emissions measures (Hess, 2011).

MOL reported that it has conducted a detailed study to assess the impact of energy transition to its business. Based on the study, the company is aiming to diversify its business portfolio to include power generation business, construct geothermal energy-based power plants and to continue developing more efficient and sustainable biofuels (Mol, 2011). Similar strategy is also being adopted by many other O&G companies. This is to ensure that broader options of energy products are available for customers during the transition phase (Hess, 2011). It could also help them, to some extent, green their businesses and carter for growing niche of sustainable energy markets. Energy transition, therefore, creates new business opportunities to the companies. It

also contributes in helping the country where a company operates in to start transitioning the country towards low carbon energy systems (Suncor, 2011).

Energy transition is a complex process that takes decades to complete. General belief among O&G companies studied is that natural gas can play a big role in the transitional phase towards low carbon energy systems (Eni, 2011; Total, 2011). Natural gas has lower carbon content than other fossil fuels and therefore, is a cleaner energy option that could help reduce the emissions. According to Total (2011), 40% of world energy is generated using coal. If the coal is replaced by natural gas, it will help to reduce carbon emissions from power generation to 50%. Hess (2011) believes that natural gas "is a game changer that has fundamentally transformed the economics of electricity generation". It will play a critical and central role in the energy mix during the transition phase (Chevron, 2011; Shell, 2011).

4.2 Types of energy being developed by oil and gas companies

In line with existing literature on energy transition, content analysis of the sustainability reports indicates that there are two types of energy transition currently happening in the O&G industry – (1) transition from conventional to unconventional O&G sources; and (2) transition from non-renewable to renewable energy sources.

Table 4: Number of companies involved in unconventional oil and gas

Types of unconventional source	Total
Shale oil/gas; tight gas	16
Oil/tar sands; bitumen	12
Heavy oil (extra heavy oil)	9
Coal seam gas; coalbed methane	7

Generally, 60% of the companies discussed about unconventional O&G development in their reports. Table 4 shows the types of unconventional sources currently being developed by the companies. About 37% of the companies did not mention that they are developing any of the sources. Among these companies are Saudi Arabian Oil Company (Saudi Aramco), Abu Dhabi National Oil Company (ADNOC) and Rosneft which are the 2nd, 6th and 11th largest O&G company in the world respectively. Overall, 13 companies are involved in the development of at least two types of the unconventional sources. Only three of them are national O&G companies (NOCs) namely China National Petroleum Company (CNPC), MOL and Gazprom Neft.

Increasing share of global O&G reserves are controlled by national O&G companies (NOCs). International O&G companies (IOCs) on the other hand, are facing deteriorating fiscal terms and increasing difficulty in accessing reserves (Kjärstad and Johnsson, 2009). The five largest O&G companies in the world are NOCs and together they are controlling about 62% of the world's total oil reserves (Petrostrategies, 2012). Edwards et al. (2010) believe that IOCs are the ones which are likely to diversify into other energy business such as biofuels. They will also continue to play important role in the O&G development since they possessed the technical know-how and the technology that are more advanced than the NOCs – they will be important service providers to NOCs (Edwards *et al.*, 2010). The result of NOCs versus IOCs involvement in the development of unconventional O&G sources mentioned earlier support Edwards et al. (2010) suggestions. IOCs are more likely to

explore O&G sources which are difficult to be accessed to increase their reserves since the 'easy reserves' are being controlled by NOCs.

Table 4: Number of companies involved in alternative energy development

Types of alternative source	Total
Biofuel/ biogas/ biomass	19
Solar	11
Wind	11
Geothermal	8
Hydropower	3
Nuclear	1

Table 4 shows the types of alternative energy sources that are discussed by the companies studied. Overall, 10 companies did not report if they are involved in the development of alternative energy. Seventeen companies are developing more than two types of energy sources – seven of them are NOCs. Among the top ten largest companies studied, only two companies gave no indication of their involvement in alternative energy.

As can be seen in Table 4, biofuel is the most favored alternative energy to be developed among O&G companies. This is because biofuel is compatible with current O&G industry infrastructure and technology. Fuel from vegetable oils and animal fat can be blended with fossil fuels to be used for transportation and electricity generation (Petrobras, 2011). It can also be used to reduce sulfur content and improve quality of diesel (Ecopetrol, 2011). Total (2011) notes that biomass is the only alternative energy that could supplement fossil fuels supply. However, it is important to ensure that the crops used to produce this fuel do no compete with crops for food supply in order for its production to be sustainable.

The companies' decision regarding the type of energy that they invest in depends on their ability to create synergies between the new energy development with current business and areas of operations. The choice also depends on the ease of access to the feedstocks which are required to develop the energy. Substantial investments are also needed for infrastructure as well as research and development activities. Therefore, various other factors must be considered before an O&G company could pursue its low carbon energy ambition.

4.3 Implications of the energy transition on oil and gas companies' supply chain management

Approximately 73% of the companies discussed about issues related to supply chain management in their reports. However, most of their discussions generally revolved around O&G supply chain. Discussions on alternative energy supply chain are mostly concentrated on biofuel.

Other sources of alternative energy are discussed on a more strategic level. This could be due to the level of involvement of the companies in the development of these energy sources. Eighteen companies disclosed that they are in planning and/or

research and development phase of the technologies. Partnership with, for example, other energy company or research institute in the development of alternative energy are discussed by eleven companies. Some companies such Repsol and Total acquired other companies to provide stronger platform for their involvement – i.e. Repsol acquired a company that promotes alternative energy projects and Total acquired a start-up company involved in developing purified silicon for solar power (Repsol, 2011; Total, 2011).

Issues which are related to supply chain management of unconventional oil and gas, and alternative energy discussed in the reports can be categorized as follows: supply management, production management and logistics management. The issues are summarized in Table 5.

Table 5: Supply chain management issues discussed in sustainability report

SCM areas	Unconventional O&G	Alternative Energy
Supply management	*Supplier selection & monitoring* - Discussion with suppliers on environmentally friendly fracking fluids; - Requirement for disclosure of chemicals used in hydraulic fracturing; *Support for suppliers' sustainability initiatives* - Participation in suppliers' initiatives to develop an infrastructure for sustainability disclosure (e.g. FracFocus's chemical disclosure registry) *Supplier development* - Use of local suppliers;	*Sustainable sourcing* - Use of local & family farmers; - Source of feedstock (i.e. from non-food crops, waste etc); - Land management / sustainable agricultural development - Inclusion of sustainability clauses into new and renewed supplier contracts; - Supplier certification; - Supplier compliance audit program; - Supply traceability – recording system of feedstock origin; - Reliability of supply (e.g. in the event related to weather etc.); *Supplier development* - Integration of family farmers and small, medium & large producers; - Establishment of farmers' networks; - Training for farmers; - Provision of inputs (e.g. for farming)
Production management	*Materials usage* - Disclosure of chemicals used in hydraulic fracturing;	*Production process* - Integration of alternative energy production

	Emissions reduction - Process efficiency; - Source of energy used in production processes *Water management* - Water sourcing, measurement and reporting; - Water supply availability and potential impairment; - Treatment of produced water; - Use of recycled water; - Water transportation system; - Water storage; *Reduce, Reuse, Recycle (3R)* - Treatment and/or disposal of byproducts according to local, state & federal regulations; *Safety, Health & Environmental risks* - Public health and safety risks; - Effect on indigenous community; - Ground disturbance	infrastructure with existing O&G production infrastructure; - Harvesting machineries; - Use of process waste to generate energy for production process *Water management* - Water use; - Wastewater management; *Life cycle assessment* - Field / agricultural area survey; - Feedstock origin; - Carbon emissions; - Environmental and community impact; - Profitability and marketability of energy produced
Logistics management	*Transportation* - Traffic safety; - Prevention of road deterioration; - Transport infrastructure	*Transportation* - Transport infrastructure

One of the major concerns in the development of unconventional O&G is the environmental impact of its production process. This issue therefore dominates the discussions on its supply chain management specifically with regard to the use of chemicals, water and energy as well as management of waste and byproducts of the production process – sustainability of shale oil/gas, tight gas and oil/tar sands and bitumen are discussed more than other sources. The measures taken to address the issue are basically similar to the ones taken in the development of conventional O&G sources.

However, due to increased attention on sustainability of hydraulic fracturing activities for the development of shale gas/oil and coal seam gas, among others, most O&G companies focus their discussions on the efforts to disclose chemicals used in the fracking activities specifically through cooperation with their suppliers. Water management was also given considerable attention by the companies since production of unconventional O&G requires the use of and withdrawal of huge amount of water. Water produced from the production process must be treated before it can be used or disposed off. Therefore, the O&G companies need effective water management systems that could help them to manage their water sources, its treatment, storage and transport.

In the case of O&G companies' involvement in the development of alternative energy, significant investment must made in the supply chain such as with regard to sourcing of feedstock and development of production and logistics infrastructure to produce and deliver the energy. Planning process may take years before initial groundwork can begin considering the investment needed. Changes to the present supply chain management structure and strategy in the O&G companies are required since alternative energy sources, to large extent, differ greatly from O&G. However, it is interesting to note that issues in the management of alternative energy supply chain basically revolve around the same issues as O&G supply chain.

While alternative energy is cleaner than oil and gas, its feedstocks must be acquired from sustainable sources and irregularity of energy supply for wind and solar, for example, could cause serious energy security issues. Production process requires effective management of water, energy and waste. Logistics infrastructure such as storage and transport systems must be efficient so as to reduce cost and time to deliver supplies to users since many of production sites are located in remote areas. Therefore, similar sustainability concerns which are associated with the management of O&G supply chain – such as sustainable sourcing, supplier management, clean production, water and energy management, waste management, carbon footprint of production process and logistics activities – are also need to be considered in the development of alternative energy.

5 Conclusions

The content analysis of O&G companies' sustainability reports revealed that the discussions on energy transition among the companies are mostly on strategic level. It was found that the O&G companies are transitioning itself towards becoming energy companies by developing alternative sources apart from unconventional O&G. While the industry is supportive to the development of alternative energy, it is also apparent that their main focus is on the development of unconventional O&G. The companies also seek for opportunities in the development of alternative energy that create synergies with their current business and areas of operations which is clearly indicated by the extent to which the alternative energy are currently being developed.

This study seeks to identify the impact of energy transition on sustainable supply chain management practices among O&G companies. Based on the findings, it can be concluded that the strategy which are being implemented by the companies – whether in the development of unconventional O&G or alternative energy – are basically similar in nature. The analysis focused on three supply chain management functions namely supply management, production management and logistics management. Regardless of the types of energy, the companies have to deal with similar sustainability issues throughout their supply chains. However, due to the limitations of the data used in this study, it is difficult to identify the structural changes in the supply chain management resulted from the diversification of the companies' businesses – i.e. changes that occurs in the key supply chain business processes and functions in the companies. Future research could look into this aspect through case studies since it enable for more detailed investigations to be conducted.

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