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The impact of environmental regulations on the business model of a maritime supply company
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An Estonian case study

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Abstract

The International Maritime Organization (IMO) and the European Parliament (EP) in 2005 and 2012 established Sulphur Emission Control Areas (SECA) in Northern Europe where ships from 2015 must use fuel with a low sulphur content not exceeding 0.1% and 0.35% in non-SECA. This has spurred active discussions that the regulation has created some economic disadvantages to maritime stakeholders who must comply with strict regulations competitors in other parts of the world are not subjected to.

This work investigates the impact of environmental regulations on the business model of maritime supply company. Based on a case study of Viru Keemia Grupp, a producer of shale oil which has a sulphur content that exceeds 0.1% and is currently faced with the challenge of a stricter regulation which imposes a lower sulphur content fuel from 3.50% to 0.50% by 2020 in non SECA, it further suggests strategic entrepreneurial compliance options available for VKG.

Sub-Theme: Impact and Sustainability

Keywords: **SECA regulations, business models, entrepreneurship, clean shipping, strategic management**

1. Introduction

The sulphur emissions (SOx) regulation - "Regulations for the Prevention of Air Pollution from Ships" was imposed during the sixth Annex of the MARPOL (International Convention for the Prevention of Pollution from Ships) Convention of the International Maritime Organization (IMO). It was first adopted in annex VI of MARPOL, 35, in 1997 through the creation of the sulphur Emission Control Areas (SECA)s, limiting Sulphur emissions in these areas to be no more than 1.5% (15,000 parts per million (ppm). This regulation also applies to other airborne emissions like NOx, ODS and VOC. This law became effective in 2005 but was further amended in 2008 to introduce more stringent rules, thus from 1 January 2015, sulphur emissions from ships in the SECAs cannot be more than 0.1% (1,000 ppm) (IMO, 2014).

On 1st January 2012, MARPOL annex VI also enforced a new global SOx cap for marine bunker fuels from 4.5 % (45,000 ppm) to 3.5% (35,000 ppm), for all ships that operate in non-SECAs (IMO 2015). The version of this directive also imposes all passenger ships in EU non-SECA waters to have a maximum 1.5% sulphur content till 2020. At the MEPC 70th session held in London in October 2016, the SOx for bunker fuel was lowered yet again to 0.5 % (5,000 ppm) taking effect from 2020 (IMO, 2016). Meaning that, irrespective of the outcome of the IMO review in 2018, a ship does not have to operate in SECA before it pays attention to the sulphur content of the fuel it uses. In order to increase life expectancy and protect the environment by reducing acid rain and particulate matter which are dangerous to human health, the EU shipping regulations have also included waters and ports in the EU (Directive 1999/32/EC amended in Directive

2012/33/EU) which puts EU-sulphur limits to be the same as SECA's. This also includes any vessel at the quays in EU ports whether it falls in SECA or non-SECA.

Since the introduction of Sulphur Emission Control Area (SECA), significant changes have been seen with some vessel that operates in the Baltic Sea who now use fuel that is low in sulphur content (Bergqvist, Turesson & Weddmark, 2015). Despite the seemingly good changes witnessed, there have been discussions on how the sulphur regulation somewhat seems to have created some economic disadvantages to maritime stakeholders who must comply with strict regulation which competitors in other parts of the world are not subjected to (Notteboom, 2010). Another flank of the argument is the possibility that these regulations will weaken the competitiveness of European maritime transport especially in the modal shift of cargo flows from marine transport to inland transport routes (Wiśnicki, 2014; OECD/ITF, 2016). Already, the implementation has been speculated to cost the maritime sector between €2.6 billion and €11 billion by 2020 (AirClim, 2011). Although a disclaimer by Airclim (2011), cautioned that these costs are mostly likely to be overestimated because technology innovations to improve ship fuel efficiency as well as the downward fluctuations of fuel cost were likely not put into consideration in this estimation.

Affected companies usually respond to regulations and regulation accumulation by changing their strategies for the innovation process. Some of their responses are embedded in activities such as research and development, expansion, equipment upgrade and processes. This has triggered the discussions on the impact of the sulphur regulations on business models of maritime supply companies, especially maritime fuel producers who in recent times have been plagued with fuel downward price fluctuations alongside the usual sector challenge of speculations and economic forecasts, conflicts in different parts of the world, production estimates from the oil producing countries, stock levels, seasonality, weather and accidents (Nugraha, 2009). Fuel producers now have to deal with producing Marine gas oil (MGO) and Marine distillate oil (MDO) all of which are distillate oils and expensive to refine (Notteboom, 2010).

This study explores the economic impact associated with the sulphur regulation and by extension SECA regulation on enterprises using the case of Viru Keemia Grupp AS (VKG), one of the largest Estonian companies and a producer of shale oil, which has a sulphur content that exceeds both the SECA and the global sulphur emission limit. Until 2015, VKG was able to produce shale oil as bunker fuel without restraints. Due to the strict MARPOL regulation, the company is presently faced with the challenge of producing 0.8% sulphur content fuel and a future stricter sulphur reduction of 0.5%. In order to meet the demand of the new regulations and to persist in a highly competitive market, going forward, VKG must make tough and strategic business decisions which are linked to high investments and serious financial risks in the maritime fuel market since successful value propositions are said to be embedded in great business models (Osterwalder & Pigneur, 2009).

The objective of this study is in two folds. First, it investigates the impact of sulphur regulations on the business processes of a maritime stakeholder using VKG a maritime fuel supplier as a case. By using the elements of the business model, it probes VKG business activities before and after the sulphur emission regulations by focusing on these research questions: What are the economic implications of the SECA regulation on the business model of the maritime company? Secondly, in the light of Panagakos (2014) summation that new regulations should encourage entrepreneurial innovation for business growth, this work will further seek to explore the possible strategic entrepreneurial compliance options for VKG.

This paper is organised as follows: Section II discussed the Sulphur regulations and the activities of the maritime sector stakeholders in their bid to comply with the environmental stipulations. Section III provides a theoretical analysis of the impact of accumulated regulations on business activities of enterprises using the Endogenous growth theory and the method used for the work. Section IV highlights VKG business processes, its challenges, how it is coping with the sulphur and other environmental regulations and possible options for its continued success. Section V concludes.

2. Sulphur regulations compliance options

Regulations that are environmental induced usually spark a lot of interest. One of the significant benefits of environmental improvements regulations such as the sulphur (SOx) regulation is the reduction of the acidification damage to ecosystems, which is expected to reduce respiratory and cardiovascular diseases and increase life expectancy (AirClim, 2011). Some studies reported that international shipping produced about 80 times more SOx emissions than aviation in 2000 (OECD/ITF 2016). Sulphur dioxide (SO_2) one of the compound states of SOx is described as a colourless toxic gas formed by burning sulphur in air through different process like manufacturing, shipping, aviation or volcano process. As a reactive gas, SO_2 reacts with other compounds to form secondary particles that have a bad consequence for the health of the inhalers (Duke Energy, 2016).

In its efforts to reduce the compliance costs, the European Commission has put forward a set of measures and has expressed its support for the promotion of innovations for new abatement technologies (IMO, 2013). Maritime stakeholders like ship operators and ports have also been forced to look for innovative ways to adhere to the stipulation of emission reductions from ships and at the same time stay afloat profit wise (Wiśnicki, 2014). On another hand, ship equipment vendors are venturing into ways of increasing their capital base and gain new business opportunities from it (EfficienSea2, 2016). Principally, two paths exist for shipping industry to comply: one is fuel switch to low sulphur fuels, including LNG and other alternative fuels, or second, to install exhaust gas cleaning devices, i.e. scrubbers in ships (OECD/ITF 2016).

Seemingly, the easiest solution to the Sulphur Regulation will be to completely change the use of fuel to low sulphur fuel. However, according to OECD/ITF (2016), approximately 80% of the total bunker fuel is heavy fuel oil (HFO) with sulphur content that is higher than it is allowed in SECAs. One of the option to comply with the sulphur regulation will be for ships to travel with more expensive and cleaner low sulphur fuel (marine diesel oil (MDO) - a distillate oil, or marine gas oil (MGO) - a higher grade distillate oil that can be treated to reach a maximum sulphur content of 0.1% for short sea shipping in SECAs. However, ships that sail on other waters other than SECAs have the option to use higher sulphur content fuel rather than the 0.1% sulphur fuels mandatory for SECA whenever they are out of SECA (IMO, 2015). The use of the low sulphur content fuel does not require any major investments in remodelling ships, except minor adjustment of tanks and engines. And large ships could choose a hybrid solution that will allow them to switch between high- and low-sulphur fuels whenever they are within a SECA (Bergqvist, *et. al*., 2015).

Liquefied natural gas (LNG) is another type of low sulphur content fuel that has arguably been widely accepted as a promising energy source for shipping in order to solve the sulphur content dilemma. The LNG is less costly when compared to distillate oil and heavy fuel oil, however, the costs of distributing LNG to ports and ships is very high and depends on the distance of the port from the LNG import terminals which is the method of distribution of LNG volumes (Brynolf et al., 2014).

The second abatement option is the use of the scrubber. This is a flue gas desulfurization (FGD) technology, which removes, or "scrubs," SO_2 emissions from the exhaust gas. Traditionally, the principle behind the scrubber is the reaction of slake lime- $Ca(OH)_2$ (a white caustic alkaline substance consisting of calcium oxide). When SO_2 combines with limestone and water with the production of heat the primary by-product is calcium sulphate ($CaSO_4$, $CaSO_3$) commonly known as synthetic gypsum - a recyclable product used in the manufacturing of wallboard and cement, and as a soil amendment in agricultural and construction applications (Duke Energy 2016; EfficienSea2, 2016).

A Ship Scrubber is a cleaning system that removes sulphur from the exhaust of ships that use heavy fuel oil (HFO). Through some technical consideration and upgrades, there are currently two major types of scrubbers: the dry and the wet scrubbers (OECD/ITF 2016). The initial investment costs of scrubbers range from EUR 2 to 8 million for a ship. The cost depends on certain features such as the ship type, scrubber type and new build/retrofit. Also, apart from the initial investment, operating the scrubbers increases the rate at which the engine consume fuel and is estimated to increase between 1-3% (EMSA, 2010). The scrubber needs space for installation together with extra space for equipment for wash water, piping systems and monitoring on the ship making it possible to use the scrubbers only in large vessels (Bergqvist, *et. al.,* 2015).

3. Endogenous growth theory and the ripple effects of accumulated regulations

Endogenous growth theory builds on the premise that economic growth of a country is primarily dependent on decisions made by actors in the economy—firms and individuals—rather than on external factors (Barro, 1991). Because productivity growth plays an important role in any economy, any distortions that adversely affect entrepreneurial activities have great significances for the growth of any economy (Solow, 1994). The innovation that stems from these activities is the key driving factor for economic grow and social wealth. Innovative products and services emerge more often because of a cross-sectorial combination of technologies, design and business models (Olaniyi and Prause, 2016).

Furthermore, regulations are said to have cumulative effects. Supporting this theory, Jaffe, Peterson & Stavins (1995) said that regulatory decisions are too time-consuming and are often characterised by litigation and other legal power struggles that lasts for decades of reforms with more policies added to the existing ones leading to what they called transition costs. Regulatory interventions impact investment choices which ultimately have a great effect on the economy because the build-up of regulations over time often lead to duplicative, conflicting, and even contradictory rules, and the multiplicity of regulatory constraints complicates and distorts the decision-making processes of companies or stakeholders operating in such economy (Martin and Sunley, 1998). Affected companies usually respond to individual regulations and the accumulation by changing their strategies for innovation process, which are embedded in activities such as research and development, expansion, equipment upgrade, and processes. Governmental intervention through regulations often leads to disruptions of investment choices (Repetto, 1990). Many of the costs embedded in regulations are indirect such as costs of new and changed personnel, materials purchased, legal costs, paperwork and the like. A single investment choice made a year has the ability to affect the proceedings of the coming years either. Wrong investment decision can cause an adverse setback, so also can indecision. Regulation imposes large direct and indirect cost on the stakeholders or more so at the society at large and it is crucial to balance the costs-benefits of such regulations by identifying and implementing flexible and cost-effective environmental policy instruments, whether it is conventional or the newer kind of market-based interventions because, if businesses are constantly subjected to avoidable expenses and investment it could lead to societal waste (Rebelo, 1991). Jaffe *et al.,* (1995) pointed out that innovation will always divert resources into R&D and that environmental regulations especially could affect productivity significantly when you consider the costs associated with reduced investments.

A major inference from endogenous growth theory is that the impact of government intervention on economic growth is not simply the sum of direct and indirect costs associated with each regulation. OECD (2005) explained that even though enterprises are constantly subjected to series of requirements and obligations through regulations, the regulations should not be seen in a negative light, as these obligations are necessary legal impositions needed in order to regulate the manner in which businesses are being conducted putting the society in considerations. Regulations may not bring financial gains sometimes and to everybody, but they create a stability which invariably is connected to wider macroeconomic benefits such as GDP increases, competitiveness and productivity effect and other unquantifiable benefits, such as protection of fundamental rights, social cohesion, international and national stability the economy status of any nation (Rendal, 2013). It is important, therefore, that while the benefits of introduced regulations are being analysed, along with it, the economic impact, compliance costs as well as the administrative burden of such additional rules should also be measured. Earlier in 2016, before the new sulphur global cap was confirmed, OECD/ITF studies had shown that, if the 0.5% global sulphur cap was considered, the cost impact of the regulations will be substantial up to 7.5% increase in agricultural goods, 3.5% in manufactured goods and 16.4% for industrial raw materials. And because maritime transport costs make up a substantial share of the value of traded goods, this may trickle down to and translate to increase in the costs of traded goods. When regulations are constantly, monitored lights are shed to places and areas that need adjustment or further governmental intervention and incentives (OECD, 2005).

4. Methodology and case study

The scope of this study is to explore the activities of a maritime fuel company in Estonia, in the Baltic region of Europe with the aim of studying the how its business activities were affected because of the Sulphur emission regulation and by extension the SECA regulations. VKG was chosen as a single study unit since a case study is one, which investigates an individual, community or group to answer a specific question by seeking evidence that lies in the case setting (Gillham, 2000). The empiric activities are based on expert interviews, observations and case study methods, which have been executed in the frame of the “EnviSuM” project during 2016.

Viru Keemia Grupp AS (VKG) is the largest oil shale producing company in Estonia. It is situated in Ida Viru County, a 148,000 populated area of Estonia. Estonia is a small country located in Eastern border of European Union (EU) close to the Baltic Sea with the population of 1.3 million. It used to be part of the Soviet Union up until 1991. Estonia is the least energy importation dependent country in Europe due to shale oil produced electricity (Eurostat 2016). Estonia predominantly uses 78.3% of solid fuels to produce energy - mainly oil shale. Oil shale covers about 65% of the country's needs for primary energy which has guaranteed the energy independence of Estonia. While the EU imports 53.4% of its total consumed energy as a whole, Estonia relied on only 11.9 imports for its energy requirements (Eurostat, 2016).

Oil shale industry contributes about 4-5% to Estonia GDP and about EUR 300M to the state budget (including employment taxes, environmental taxes) (Eesti põlevkivitööstuse aastaraamat, 2014). As a producer of shale oil VKG can be said to be one of the companies that have a significant impact on Estonia economy. In 2015, VKG's contribution to the state budget of Estonia was up to €35 Million and Company's total turnover was €167 million. From the turnover, € 87 million was contribution from shale oil alone (Table 1). VKG solely started as a shale oil producer but over the years have expanded and diversified its value chain to about 10 enterprises: oil, heat and power generation, heat distribution, electricity distribution, power system construction, oil shale mining, cinder blocks production, metal structures, pipelines and pressure equipment production, logistics, assemble and repair companies. As of 2015, VKG has employed over 2100 employees.

Table 1: Business analysis of VKG from 2006-2015

Year	Turnover million (€)	Shale oil contribution million (€)	Investment million (€)	Percentage of investment to turnover (%)	Profit Million (€)	Number of employees
2015	166.8	87	59	19.5	-31.9	2101
2014	195.2	128	98	50.2	19.8	2206
2013	220.4	146	90.9	41.2	26.2	2013
2012	215.8	148	65.9	30.5	26.2	2000
2011	183.6	124	51	27.7	37.4	1610
2010	125.5	83	34.4	27.4	19.2	1406
2009	107.5	59	39.9	37.1	9.2	1312
2008	131.5	78	77.3	58.7	14.7	1381
2007	114.2	62	49.5	43.3	18.8	1369
2006	97.1	55	29.0	29.8	19.1	1374

Source: VKG 2015 Financial statement (2015 Yearbook)

Oil shale and Shale oil - Oil shale production

Oil shale is a sedimentary rock, which in its mineral state contains a solid, combustible organic matter commonly called "kerogen" (Siirde, et al., 2013). As a solid material, it undergoes thermal treatment to produce shale oil and other products (coke and phenols). In VKG, the by-product waste gas formed in shale oil production is used as a fuel for heat and power co generation. The produced shale oil is useful as a quality-improving supplement for HFO or diesel supplement in industrial boilers and furnaces. Oil shale (raw material) in its solid state is extracted from underground mine of VKG Ojamaa mining site. Over 3.4 million tonnes of commercial oil shale of both fine and coarse grade is produced annually from Ojamaa mining activities.

After mining, oil shale is transported to Kohtla-Järve for processing in approximately 52 minutes with a 12.5 km conveyor (a piece of mechanical handling equipment that transport heavy and bulky materials from one end of location to another at production sites). VKG uses two types of technology to produce shale oil: The **Kiviter technology** (a gaseous heat carrier) and the **Petroter technology** (a solid heat carrier method). Thus shale oil is produced from a low-calorific (8-8,5 MJ/kg) and fine-grain (0-25mm) oil shale (Petroter technology) or from oil shale with higher calorific value (10-13 MJ/kg) and larger fraction (25-125 mm) (Kiviter technology). Figure 3 shows an integrated production diagram for a typical production of shale oil in VKG. The Kiviter technology plant is a historical heritage on the VKG oil-processing site while the first Petroter plant was commissioned only in 2009.

In the thermal treatment, about 50-57% of oil shale energy is converted into liquid product (shale oil) energy while about 15-17% of oil shale energy is converted to gaseous by-product (waste gas) energy. The heat recovery process in Petroter technology adds another 7-8% to the energy yield and the production of the solid by-products (mainly coke products) adds about 4 % energy yield. The gaseous by-product is used as fuel in the combined heat and power (CHP) plant. In order to increase its energy production efficiency, a €20 million investment was made in an 18km Kohtla-Järve – Ahtme district heat pipeline to supply district heat (DH) to the districts of Ahtme and Jõhvi.

Other by-products of the process are phenolic water, flue gas and ash or semi-coke from thermal processing. Phenolic water is further used in phenolic extraction for fine chemicals production. Air (CO2) and water emissions are released during shale oil production. There is also the residual solid waste (semi-coke and ash) from the processing. Oil shale ash and semi-coke wastes are reused up to 1 million tonnes per year and most of the solid waste from a longer oil shale processing are used to landfill. For the wastewater management, VKG uses the separate industrial/municipal sewerage - a rainwater collection system and 2 separate industrial wastewater pre-treatment plants on the site. Due to its proximity to residential houses, the company has invested considerably in the elimination of unpleasant odour. The storage tanks are equipped in such a way that loadings are performed with closed breathing system and from 2016, all the flue gas from CHP plant undergoes desulphurization.

The majority of VKG shale oil customers are some of the largest oil traders in the world. VKG Transport, a VKG subsidiary is responsible for its logistics and uses freight on board (FOB) - Sillamäe delivery for most of its distribution activities. The distribution process starts from the production site through the rail which transports the Shale oil directly to the Sillamäe port where tankers can pick it up for delivery to Rotterdam. Currently, there are marginal sales of VKG products to refineries, however, the majority of the liquid product mass is not sold to refineries but blended directly into product bunker fuel instead.

6. Results and Discussion

The sulphur content of shale oil is around 0.8%, this is higher than the 2020 global sulphur limit, more so the SECA limit. Although VKG sells its fuel directly to oil traders and not to the end-users, considering the sulphur content of 0.8% w/w as average in shale oil products, might give a negligible possibility that the product is being used in SECA bunker fuel blend. Apart from its high sulphur content fuel by the IMO SECA sulphur regulation standard, shale oil has a viscosity-density relationship preferable for specific purposes: especially for improving HFO flow properties and pour point. This is one of the key selling points of shale oil. The density and viscosity are both within the range of ISO8217 residual marine fuel specification. Depending on the fraction, the largest portion of blended oil products has a density between 0.99 -1.02 kg/L and a kinematic viscosity between 20 -105 cSt. In the context of ISO 8217:2012 residual marine fuels characteristics, majority of shale oil products marketed fall into the marine oil density RMK and the viscosity RMD low range. This fact, however, does not separate VKG from the realities of the evolution in bunkering fuel and the regulations that surround it.

VKG as an oil production company is subjected to diverse environmental laws and regulations and has a centralised environmental department (ED) that provides services to all subsidiaries in VKG group. This department is responsible for the preparation of applications for environmental permits, environmental reporting including reporting of resource consumption and pollution for determination of environmental taxes, and managing environmental impact assessment procedures if designated. VKG ED is also responsible for European Union (EU) Emission Trading System (ETS) reporting, registration and applications of VKG group subsidiaries. It monitors the best available technology (BREF) documents, EU environmental legislations, Estonian and other governments draft legislation information system. In order to get information about new initiatives, it keeps a direct and close contact with the Ministry of Environment. Because of its industrious promotion of environmental awareness activities, VKG has been consistently awarded the title “The Responsible Estonian Business” from 2010 to 2015.

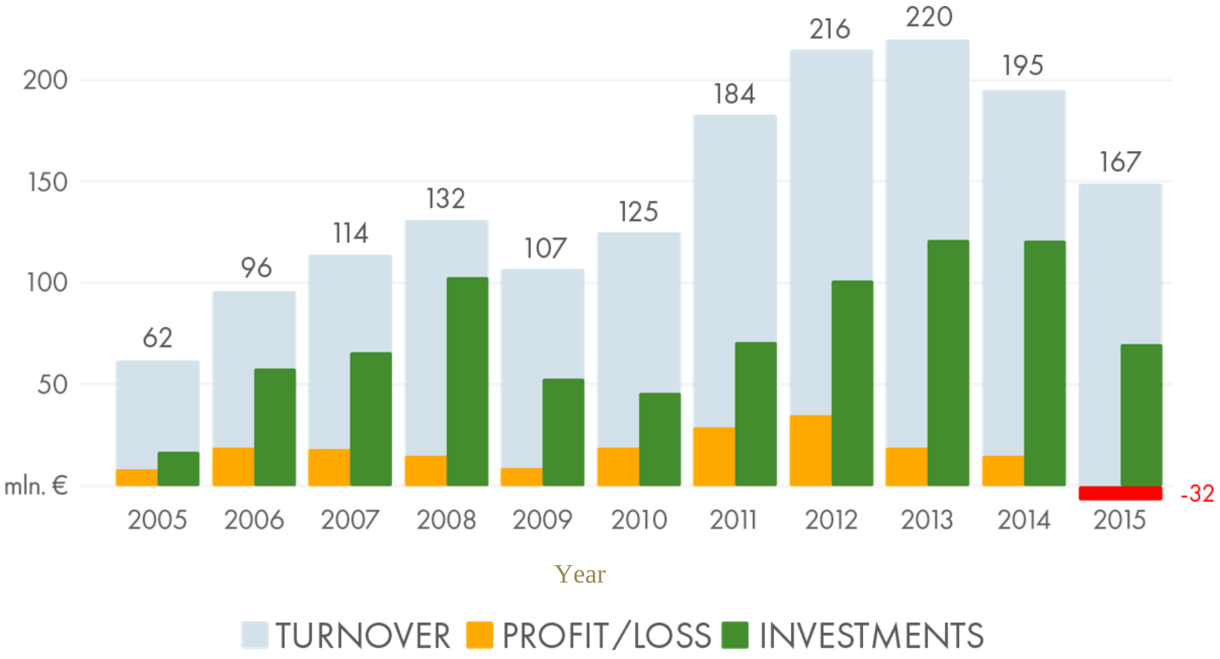
VKG response to the SECA regulation was to come ahead with the refinery project (a project that was in the pipe) along with process innovation and the elongation of its product portfolio, especially by-products. Before the SECA regulations, VKG had started a feasibility study on building its own refinery and bunker fuel market change research, a project that cost VKG about €5.5 million. Business wise, running a refinery would have meant a product innovation that will yield Euro V Diesel (a majority of the production) and 0,1% Sulphur marine fuel oil and stabilised naphtha outputs. However, the outcome of the research could not dispel the uncertainties that surrounded the 2015 sulphur regulations and the uncertainties that surround the market reaction to the sulphur regulations. For instance, the impact price spread between the HFO and the MGO will have impact on the decisions of some of the sectors in maritime. A higher price spread means ship operators will invest more in the scrubber technology that will enable them to use the high sulphur content fuel while a low spread price would remove the financial restriction to buying the expensive and 0,1% sulphur fuel increasing the demand for MGO. Also the possibilities of additional related regulations from MARPOL that could negate some of the efforts or milestones made in the first regulation compliance.

Furthermore, the feasibility studies also showed that at the Front-End Engineering Design (FEED) stage, the cost of the refinery for the raw material processing capacity of 133% VKG shale oil production at 14 000 barrels per day and 750 000 tons per year, was estimated to be a staggering sum of 400 Million EUR coupled with the 5% depreciation of 20 Million EUR annually. This confirms how risky taking on a project of that magnitude would be making the management of the company to putting the refinery project on a hold. The risk is further magnified because VKG have had to constantly struggle with uncompetitive and high fixed costs of its fuel production when compared with that of crude oil and because of the downward fluctuation of the fuel price. Because oil shale is not a common product found in regular refineries, its refining process and activities are quite limited. This attributes also makes it difficult to use standard technology used in the refining process. Even though VKG has access to a resource based operating mining group, the oil shale resource allocation is smaller than its processing capacity making VKG to only use only 70% of its shale oil production capacity (520,000ton/year).

A look at the breakdown trend of VKG 10 years' financial activities in figure 1 and table 1 shows the sizeable contribution of shale oil to the annual turnovers, although 2015 shows a decrease in shale oil contribution. Also for the first time in 10 years, VKG recorded a loss in 2015. One logical and obvious explanation to this is that oil price has fallen drastically, a bitter pill any operating oil company is forced to swallow. A further look also shows the company's 2015 investment was low as a percentage of the annual turnover (19.5%) when compared to previous years.

The harsh reality is that VKG will continuously be threatened with unending legislations, regulations, environmental lawsuits laws that will keep the company perpetually on its toes. It will also continue to face the challenge of available open markets for its products and the uncertainties that surround fuel prices. VKG products major competitors which are mainly refinery products will in the near future be an increased competition to another fuel source like LNG, renewable fuels (II generation biofuels), and methanol.

Figure 2: Financial statement of VKG Year 2002-2015



Source: VKG AS 2015 Financial statements

Strategic entrepreneurial compliance options for VKG

Due to the new global sulphur emission cap, VKG has found its self in a position where it must make the assessment on the impact of sulphur regulations on the marketability of their oil products post 2020 and going forward on the most feasible alternative for conformity with the regulations business wise. Thus, VKG is faced with a blend of 5 strategies:

1) **Upward vertical integration**: Blending VKG shale oil with the 0.1% MGO or other low-sulphur content fuel, which will be an upward vertical integration in its supply chain process. In this case, VKG will sell directly to its suppliers and will solely be in charge of how these products are supplied.

2) **Products Upgrade**: Building a new refinery which could results in a change of marketable products portfolio for VKG such as V Diesel, 0,1% Sulphur marine fuel oil and stabilised naphtha. Refining shale oil will also yield commercially valuable products that can be used as the substitutions for petroleum derivatives with only minor modifications and adjustments of the operating conditions (Akash, 2003). The refinery would seem like a good investment decision for VKG due to the increased process capacity - an improvement to the present capacity by mile together and according to the preliminary report, would produce an output of stabilized gasoline fraction of 61, 000 tons per/year; Euro V diesel 349 000 ton/year; SECA fuel oil 303 000/year. Additionally, there would have been 7300-7500 tonne/year elementary sulphur produced. However, the costs involved would have been higher than the stated capital expenditure (CAPEX) of 400million Euro since additional investments in operational cost (OPEX) are estimated to be between 30-50 million EUR/year.

3) **Hydrodesulphurization**: The treatment (partial hydrogenation) of product oil for sulphur removal (desulphurisation) is a chemical reaction between molecular hydrogen (H_2) and another compound or element in this case - sulphur, with the help of a catalyst (Kabe, Ishihara and Qian, 2000). Heavier distillates are usually broken down through this process. While this process will solve the sulphur content challenge of shale oil, hydro-desulphurization might cost VKG between €100 - 150million Euro capital investments. This option is in direct competition with VKG keeping the status quo of selling its products to the bunker fuel traders. Before taking this step VKG must be able to answer the question about the future price spread between the HFO and MGO in order to assess the return of this type of investment. Even experts are finding it difficult to speculate fuel prices, for example, Notteboom et al., 2010; COMPASS, 2010 & Hämäläinen et al. (2016), discussed in their studies several-failed attempt by market expert to forecast fuel prices. Consequently, the uncertainties surrounding the fuel prices will make it risky for VKG management to make any calculated investment decision.

4) **Product Discount**: VKG can continue marketing of its existing 0.8% w/w sulphur content product but with a discount to traders if the future spread between less 0.5% Sulphur fuel oil and less 1% Sulphur fuel oil. In the first place, because shale oil is sold to traders there is a high possibility that its oil is still used in SECA bunker fuel blend. Therefore, with a proper incentives and trade terms, VKG will likely keep the current or most of the current customers.

5) **Process innovation**: Process innovation, an implementation of a significantly improved production method (Utterback, 1994) will increase and improve VKG efficiency (energy efficiency, a mass yield of products and labour productivity) as a key factor for sustainability post-2020 global sulphur cap. VKG can also make use of the Industry 4.0 automation and data exchange in manufacturing technologies to improve its business and process efficiency, pay better attention to the potential of its other products and convert their opportunities to maximum profits.

7. Implications

Currently, VKG is still conferring and weighing its options on how to go forward in the face of the 0.5% sulphur content fuel production, but it does not have the luxury of time before 2020 when the regulation will take effect. Apart from the investment that would be made in the refinery and bunker fuel market change research, VKG has been deliberating on what course of investment actions to take next due to the results of the research. Having been already adversely affected by the downward fuel price fluctuations, VKG must proceed strategically and cautiously towards what investment decision to make. Strategically because, while VKG may still be able to sell its fuel directly to bunker traders, there will be continued interest in improving air quality along with renewal concern about air pollution from shipping activities and at any time, follow up regulations might come up to interrupt the distribution channels. A stance of indecision will likely prevent a wrong choice of investments, on the other hand, delayed investment could also be just as risky emphasising Rebelo (1991), conclusions on the adverse effect of investment indecision. The constant loss of opportunities is counterproductive for any company in any given business environment. VKG also need to proceed cautiously because nobody is sure about the fuel market nor the success of the available abatement technologies for sulphur emissions. For the sulphur regulations to be effective there is a need for availability of low sulphur fuel (Hämäläinen *et al*., 2016) which in a way could be disadvantageous for VKG since the economic feasibility of shale oil is highly dependent on the markets of conventional crude oil. A high supply of MGO connotes a decline in the demand in HFO.

As Rebelo (1991) has explained, regulations do not have the same economic impact on large companies as they do for smaller companies. By a company's size, they are on different scales and can be quite substantial. The smaller companies could sometimes lack the capacity to handle the needed compliance changes that come with regulatory decisions. The shipping industry incurs such a significant cost hence for sulphur regulation to be rational, there must be an allowance for a level playing among related stakeholders. However, the importance of the company to the economy development of Estonia cannot be downplayed. In the past 10 years, the company has invested close to € 900 million and is responsible for over 2,100 jobs, of which, 600 was created within 2011 and 2014 in Estonia. VKG is the largest shale oil producer in Estonia and oil shale covers about 65% of the country's needs for primary energy which has made Estonia energy independent cutting almost to zero the importation of energy to Estonia. The oil-shale industry alone contributes approximately between 4-5% (about €300million) to the national GDP. In Ida-Viru County, the industry is responsible for over 6,600 direct and about 13,400 indirect employees, which are about 20% of the total regional workforce (Eesti põlevkivitööstuse aastaraamat, 2014).

8. Concluding Comments

Clean shipping as a vision was set to make maritime transport greener, and is presently being achieved through new technologies and changed behaviour on board across all stakeholders in maritime in a concerted and integrated efforts of multiple measures. The underlining fact is that compliance with emission regulations will be related to significant investment decisions for the maritime stakeholders and large uncertainties will always encompass each regulation.

The VKG case has confirmed that not all regulations are created equal in terms of their costs or their benefits. For example, market-based or economic-incentive regulations, such as those based on tradeable permits are likely going to be more cost-effective because they provide incentives for companies to adopt process that will comply with the regulation, unlike regulations that require technological adoption or an establishment of conventional performance standards like the Sulphur emissions regulations. Stimulating innovation in the maritime sector for a cleaner environment is crucial and technology development may be able to show the way out of some persistent environmental problems but, a technical solution to a problem should not set the foundation for the creation of others. VKG as a company and the oil shale industry are important actors in the growth and prosperity of Estonia, any massive distortion to this industry will definitely have a negative consequence on the national economy.

This study contributes to ongoing discussions on the impact of regulation on business performance and to EU regulation objective that seeks to *"demonstrate clear added value… full benefits at minimum cost …. with simple, clear, stable and predictable regulatory framework for businesses, workers and citizens"* (EU, 2012) by identifying the economic implications of the MARPOL sulphur emission regulation to the business model of a maritime fuel supply company. It further discussed possible strategic compliance options available from the opportunities that are both inherent and external to the case company. This type of contribution will improve the innovation capacity of related maritime companies and the integration of new knowledge for the maritime sector.

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