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Case study: Refineries in Vietnam

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Introduction

Vietnam has set ambitious fuel quality standards in an effort to curb worsening air pollution from vehicle emissions (Clean Air Asia; Vietnam Environmental Administration, 2013). At the same time, the country aims to reduce its heavy reliance on imports of refined petroleum products, which have grown by 9% annually over the past 8 years (Vung Ro Petroleum Ltd., 2013; PetroVietnam, 2010). Vietnam's solution kills two birds with one stone: by upgrading its single existing refinery and constructing several new ones with advanced technology, the country will produce clean fuel domestically.

Vietnam's first and only refinery, the Dung Quất refinery, has been in production since 2009 and produces diesel and gasoline that meet Euro 2 standards (PetroVietnam, 2010). It is currently undergoing a major upgrade and capacity expansion and is expected to begin production of Euro 5 diesel and gasoline in 2016 (PetroVietnam, 2010; Hydrocarbon Processing, 2013a; Oil & Gas Refining & Petrochemicals, 2013). At the same time, several new refineries are being constructed. The Vung Ro refinery (completion date: 2018) will produce Euro 5 fuel (VRP, 2013), while the Nghi Sơn refinery (completion date: 2016; Thanhien News, 2013; Platts, 2013a) and the Long Son refinery (completion date: 2018; Saigon Times, 2013; PetroVietnam, 2010) will meet Euro 4 standards. The location of each of these refineries is shown in Figure 1. Vietnam is also considering the construction of a refinery at Nhon Hoi (Asian Legal Business, 2013).

Figure 1. Locations of planned refineries and refinery upgrades that will produce low sulfur fuel in Vietnam.

Fuel quality regulations and history

Vietnam's current fuel quality standard is Euro 2: the sulfur limit is 500 ppm for both diesel and gasoline (Clean Air Asia; UNEP, 2014; Petrolimex, 2009). In September, 2011, Vietnam's Prime Minister Nguyen Tan Dung approved a new roadmap for fuel quality and vehicle emission standards. Starting Jan 1, 2016, diesel and gasoline must meet the Euro 4 standard (50 ppm sulfur limit), and by Jan 1, 2021, road fuel must meet Euro 5 (10 ppm sulfur limit; Clean Air Asia). Vietnam is leapfrogging over Euro 3 to achieve cleaner fuel faster. Improvements in vehicle emission standards will lag fuel quality standards by one year: at the beginning of 2017 vehicles must meet Euro 4 (and motorcycles must meet Euro 3), and by 2022 the vehicle emission standard will be Euro 5 (Clean Air Asia).

Vietnam has recently made major new discoveries in its oil and gas reserves as a result of aggressive exploration,

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increasing the estimate of its crude oil reserves from 0.6 billion barrels in 2011 to 4.4 billion barrels in 2013, bringing it to second place in crude oil reserves for East Asian countries behind China (EIA, 2013a). Vietnam plans to expand offshore production to meet domestic demand and to contribute to state finances (EIA, 2013b). However, it currently has little refining capacity and prior to the opening of the Dung Quất refinery in 2009, had none (EIA, 2013a). To encourage growth in the country's refining sector, Vietnam established a significant tariff on all exports of crude oil (The Canadian Trade Commissioner Service, 2011; EY, 2013).

Diesel fuel prices in Vietnam are controlled by the government,[1] resulting in an effective subsidy, although the entire cost of this subsidy to the government was zero in 2009 and 2010 due to low market prices for diesel in those years (UNDP, 2012; IEA, 2011).

Dung Quất refinery

REFINERY HISTORY AND CAPACITY OVERVIEW

The Dung Quất refinery, located in Vietnam's Quảng Ngãi Province, was originally planned in 1998 with the primary motivation to produce refined fuel domestically. Construction began in November 2005, and the project was finished in early 2009. The Dung Quất refinery began production in February, 2009 (Hydrocarbons Technology, 2014). The Dung Quất refinery was originally estimated to cost US$1.3 billion (Hydrocarbons Technology, 2014) but the eventual tab totaled US$3 billion (Thanhnien News, 2013; BSR, 2013; PetroVietnam; 2010). This was financed in part by the Bank for Foreign Trade of Vietnam (US$250 million; Hydrocarbons Technology, 2014). The refinery is owned by Vietnam's state-owned oil company, Vietnam Oil and Gas Group (PetroVietnam, 2010), and currently has an internal rate of return (IRR) of 8% (PetroVietnam, 2010). The Dung Quất refinery was operated by Technip when it first began production (Hydrocarbons Tech, 2014) and the current operator is Binh Son Refining and Petrochemical Company (BSR, 2013; Viet Nam News, 2013).

The Dung Quất refinery has a capacity of 6.5 million tonnes crude per year (BSR, 2013; PetroVietnam, 2010), meeting about one-third of Vietnam's domestic demand for gasoline and diesel (ACFA, 2009). The refinery processes mostly sweet crude from the Bach Ho oil field offshore Vietnam in the South China Sea, and from this produces diesel at around 150 ppm sulfur. The fuel from this refinery would actually meet Euro 3 standards except for its olefin levels.

1 Decision 78/2008/QD-BTC (MoF, 16 September 2009)

REFINERY PROJECT OVERVIEW

The Dung Quất refinery is currently undergoing an upgrade and capacity expansion to 10-12 million tonnes and is expected to recommence production in 2016 or earlier (Gazprom Neft, 2013; Thanhnien News, 2013). One major reason for the upgrade is that production at Vietnam's Bach Ho oil field is declining, and upgraded technology is necessary to be able to process sour, imported crude (Hydrocarbon Processing, 2013a). After the upgrade, the Dung Quất refinery is expected to process a 50/50 mix of Bach Ho sweet crude and sour crude from the Middle East (Viet Nam News, 2013, Reuters 2011, PetroVietnam, 2010). It will include hydrodesulfurization (HDS) units, or hydrotreaters, for both gasoline and diesel, as well as pre-flasher, mercury removal, and VDU units (PetroVietnam, 2010). The gasoline and diesel will meet Euro 5 standards (Gazprom Neft, 2013; Oil & Gas Refining & Petrochemicals, 2013).

The expected product slate for the upgraded Dung Quất refinery is shown in Table 1 (data from PetroVietnam, 2010).

Table 1. Expected product slate for the Dung Quất refinery after its upgrade and expansion.

Product	Quantity (million tons per year)
Liquefied Petroleum Gas (LPG)	0.4
Regular gasoline	2.9
Premium gasoline	1.2
Jet A-1/Kerosene	0.7
Diesel	3.1
Fuel Oil	0.9
Total liquid products	9.2

REFINERY FINANCING

The upgrade and expansion of the Dung Quất refinery is expected to cost US$1-2 billion in total (PetroVietnam, 2010; Reuters, 2011). The project is targeting annual revenues of $5.75 bn (Thanhnien News, 2013) and is expected to achieve an IRR of 9.4% (PetroVietnam, 2010). The upgraded refinery will enjoy the same tax incentives as before, which may include tax exemptions for imported oil, machinery, and equipment (PetroVietnam, 2010).

The Russian oil and gas company Gazprom Neft will acquire a 49% share in the upgraded refinery and its investment in the upgrade and expansion will be proportional to that stake (Gazprom Neft, 2013; Hydrocarbon Processing, 2013a; Oil & Gas Refining & Petrochemicals, 2013). PetroVietnam will maintain ownership of the remaining 51% of the refinery. PetroVietnam's share of

the project is financed through the Japanese Mizuho Corporate Bank Ltd (Dung Quat Economic Zone Authority, 2010).

Nghi Sơn refinery

REFINERY PROJECT OVERVIEW

The Nghi Sơn refinery is currently under construction in the Thanh Hóa Province of Vietnam and is expected to be completed in 2016 (Thanhnien News, 2013) and begin production in 2017 (Vietnam Net, 2013). It will have a capacity of about 10 million tons per year (Thanhnien News, 2013; Foster Wheeler, 2009) and will include residue catalytic cracking and residue hydrodesulfurization units and reformers producing 145 kilotonnes hydrogen annually (Foster Wheeler, 2009). The refinery will process Kuwaiti crude, supplied exclusively by Kuwait Petroleum International (Foster Wheeler, 2009; Aetin, 2013), which is likely sour, and produce diesel and gasoline meeting Euro 4 standards (CAI-Asia, 2010; Platts, 2013a). The project will be managed by a subsidiary of the Global Engineering and Construction Group (Foster Wheeler, 2009).

Construction of the Nghi Sơn refinery was delayed by five years due to problems attracting financing: it was approved by the Vietnam government in 2008 but only closed financing in July, 2013 (Platts, 2013b; Vietnam Net, 2013).

REFINERY FINANCING

The refinery construction is expected to cost around US$8-9 billion (Thanhnien News, 2013; Foster Wheeler, 2013). Ownership of the project is shared between PetroVietnam (25.1%), Idemitsu Kosan Co. (Japan's second-largest refiner; 35.1%), Kuwait Petroleum Corp. (35.1%), and Mitsui Chemicals Inc (4.7%) (Bloomberg, 2010). About half of the financing for the project will be provided by these investors themselves; the remaining half will be provided by financial institutions, including $2.3 billion from Japanese JBIC and South Korean Kexim, and $2.7 billion from commercial loans guaranteed by Nippon Export and Investment Insurance (NEXI; Hellenic Shipping News, 2013; Vietnam Net, 2013).

The output from the Nghi Sơn refinery will be largely destined for the domestic market. Petrovietnam will purchase the majority of output at Asian market prices, but the refinery will be allowed to export any excess production to avoid reducing the refinery's rate of operation (Hydrocarbon Processing, 2013b).

Vung Ro refinery

REFINERY PROJECT OVERVIEW

The Vung Ro refinery is a project in Phu Yen Province. The managing company has stated that it expects to begin production in 2018. A seaport, power generation plant, water treatment and distribution system, and other facilities will be built in tandem. The seaport is planned to facilitate crude oil imports (VRP, 2013).

If completed as planned, the Vung Ro refinery will have a capacity of about 8 million tons per year (Oil Trends, 2013), and will process sour Arabian light crude as well as an unidentified "Vung Ro Petroleum blend," which is likely sweet crude from Vietnam (VRP, 2013). The managing company plans to produce diesel and gasoline meeting Euro 5 standards, and some may be exported (VRP, 2013). The expected product slate is shown in Table 2 (calculated from VRP, 2013).

Construction of the Vung Ro refinery was originally scheduled to begin in 2008 but was delayed following problems in the land clearance process and because the construction plans were heavily revised in 2012 (Oil & Gas Journal, 2008; Asian Legal Business, 2013).

Table 2. Expected product slate for the Vung Ro refinery.

Product	Quantity (kpbd)
Liquefied Petroleum Gas (LPG)	15-24
Gasoline	124-134
Jet Fuel	33-41
Diesel	149-163
Fuel oil	0-54
Byproducts	63-73
Total liquid products	363-374

REFINERY FINANCING

The Vung Ro refinery would be the first refinery in Vietnam to be fully privately owned and operated, if financed and completed as planned. The refinery is managed by Vung Ro Petroleum Limited (VRP) and is owned by Technostar Management (51% share) and Telloil (49%; Oil & Gas Journal, 2008). Neither Technostar nor Telloil have a public profile or declared assets; it is not clear if they are established companies that existed before the Vung Ro financing deal, nor where the funds will actually be sourced (by bank loans through these two companies, etc.). It is also unclear whether or how these companies are linked to existing refinery operators. The project, including the seaport and other facilities, is expected to cost US$4 billion, which would be inexpensive compared to the other refineries reviewed here, if completed as planned (VRP, 2013).

Long Son refinery

REFINERY PROJECT OVERVIEW

The Long Son refinery began construction in late 2013 in Vietnam's Ba Ria-Vung Tau province and is expected to be completed in 2018 (Saigon Times, 2013; PetroVietnam, 2010; Wall Street Journal, 2013). It will have a capacity of 10 million tons crude per year (about 11.4 million tonnes per year) with a possible expansion to 20 million tonnes, and will process only imported feedstock, including crude oil from Qatar Petroleum (Platts, 2012). The Long Son refinery will produce gasoline and diesel meeting Euro 4 standards (PetroVietnam, 2010).

REFINERY FINANCING

The Long Son refinery is expected to cost US$4.5 billion to construct. The stakeholders in the project are PetroVietnam, Siam Cement Public Company Ltd (SCG), Qatar Petroleum, and Vietnam National Chemical Group (Saigon Times, 2013).

The project will receive several tax benefits, including tax exemptions for crude oil imports and machinery and equipment (PetroVietnam, 2010).

Barriers/opportunities to low sulfur fuel adoption

The simultaneous construction and upgrading of several refineries has allowed Vietnam to leapfrog standards, moving quickly to more stringent fuel quality standards than other countries in its region. Other countries seeking to build domestic refining capacity should follow this example and take the opportunity of new construction to adopt a fast timeline for fuel quality standards.

If each of these refinery projects is completed as planned, Vietnam's refining capacity will far exceed domestic demand for fuel (Table 3). This potential excess supply has been criticized by some (Tuoitre online, 2013), but would give the country the opportunity to export low-sulfur fuel to other countries in Asia or elsewhere that may be considering tightening fuel quality standards but do not have sufficient domestic refining capacity (e.g. Indonesia).

Table 3. Expected capacity and cost of Vietnam's planned refineries, compared to current domestic fuel demand.

Refinery	Crude processing capacity (million tons per year)	Expected project cost (billion USD)
Dung Quất (post-expansion)	10-12	4-5
Nghi Sơn	10	8-9
Vung Ro	8	4
Long Son	10-20	4.5
Nhon Hoi	19-20 (VNExpress, 2014)	21.5
Total	57-70	42-44
Vietnam's total domestic demand for refined petroleum products	19 (EIA, 2013a)	

Conclusions and lessons learned

The case of Vietnam shows how the expansion of refining capacity can enable a country to move quickly to stronger fuel quality standards. Countries that rely heavily on imports of refined fuel can kill two birds with one stone by building new, modern refineries producing clean fuel, especially if they have active oil production.

These refinery construction and upgrade projects will allow Vietnam to meet its roadmap for low sulfur fuel: implementing the Euro 4 standard in 2016 and Euro 5 in 2021. If all of these projects are successful and completed as scheduled, Vietnam will more than meet domestic demand for low sulfur fuel through domestic production. Unexpected delays in the Dung Quất and Nghi Sơn refinery projects could conceivably result in delays in implementation of Euro 4. The 2021 target for Euro 5 fuel will likely be met by domestic production unless delays are serious for multiple refinery projects.

While the state-owned Petrovietnam holds a stake in each of these projects except Vung Ro, there is considerable foreign investment in these refineries. In at least one case, a national oil company from another country is investing in a Vietnamese refinery. Part of the appeal to the Kuwait Petroleum Corporation (KPC) of this investment in the Nghi Sơn refinery seems to be that the refinery will process only crude purchased from Kuwait Petroleum International, a subsidiary of KPC. Similarly, the Long Son refinery is partially financed by Qatar Petroleum, which will sell crude to the refinery after construction. In both of these cases, the investor will have a guaranteed market for its crude while the refinery will have guaranteed supply. Attracting foreign investment in new refinery construction and refinery upgrades could be an important avenue to financing desulfurization in other countries that do not have sufficient government capital available.

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