Oil and Natural Gas Logistics

HIGHLIGHTS

■ **OIL LOGISTICS -** Oil logistics include transportation of crude oil from the production sites to refineries as well as transportation and distribution of oil products to the customers. Oil tankers serve the majority of the international trade of crude oil and oil products while pipelines are mostly used for domestic transportation. Rail and trucks are also used for short-distance oil transportation. Larger tankers usually carry crude oil while smaller tankers carry refined petroleum products. Oil tankers are mainly equipped with diesel propulsion. Large tankers use less fuel per km, hence emit less CO_2 compared to smaller tankers. As for pipeline transportation, crude oil is usually piped to refineries and oil products to large customers and distributors. The energy required for pipeline transportation depends inter alia on volumes, pipeline diameter and oil quality. Oil can be stored in land-based tanks and on-board oil tankers for either energy security reasons and profit purposes, the latter based on short-term variations of the oil price.

■ **NATURAL GAS LOGISTICS -** Quantity (volume) and distance are key elements to determine the most suitable and profitable transportation technology for natural gas. For larger volumes pipeline transport is profitable for short to medium distances and liquefied natural gas (LNG) – which has 600 times smaller volume compared to natural gas in gaseous phase - is profitable for larger distances. Several competing technologies including electricity production and compressed natural gas are suitable for small volumes. The LNG technology includes natural gas liquefaction, shipping by fleets, and regasification of natural gas at the receiving terminals. The natural gas is then delivered onshore by e.g. pipelines and distribution networks. The cost of the liquefaction plant has decreased significantly during the past decades due to improved technology and increased plant size. LNG fleets are traditionally fuelled with heavy fuel oil, however diesel propulsion has become more common during the past years. Natural gas can be stored underground and on-board LNG fleets for either energy security and commercial purposes.

■ **POTENTIAL DEVELOPMENTS AND BARRIERS -** Oil and natural gas are dominant components of the present energy system and are expected to remain so for decades. Future developments of oil and gas logistics depend on oil and gas market expansion, energy security and international trade issues. In general, oil and gas importing countries (typically OECD countries) have already mature oil and gas logistic infrastructure, which expansion is only considered for energy security purposes. By contrast, emerging economies such as China and India are quickly expanding their oil and gas infrastructure to meet their growing energy needs. Uncertainties on future developments of oil and gas infrastructure and possible structural changes relate to the impact of future climate policies and the recent focus on reducing greenhouse gas (GHG) emissions. For example – assuming a widespread use of carbon capture and storage (CCS) technologies - LNG fleets could not only be used to supply natural gas to consuming markets but also to transport CO_2 to suitable storage sites. Policies to mitigate greenhouse gas emissions could also lead to the need of CO_2 capture from the LNG liquefaction process as well as in the use of low-carbon fuels (e.g. biodiesel) to fuel both oil tankers and LNG carriers

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OIL LOGISTICS: PERFORMANCE AND COSTS - Oil logistics includes typically transportation of crude oil from the production sites to refineries as well as transportation and distribution of oil products to markets and customers. Oil logistics accounted for between 5% and 10% of the oil market value in 2005 [1]. However, its share of the total oil market declines with increasing oil prices. Technologies for “open-sea” transportation include oil tankers and pipelines, while land transportation is mainly based on pipelines, trains and trucks (for distribution). The majority of international trade is based on open-sea transportation by tankers while pipeline are more used for domestic transportation. The international trade of oil has increased significantly during the last decades and in 2009 has reached the level of 52,930 kilo barrels per day (kb/d) [2]. The Middle East was the largest exporting region, with 18,425 kb/d, i.e. 16,510 kb/d of crude oil and 1915 kb/d of oil products [2].

■ **Open Sea Transport –** Oil tankers for open-sea transport are categorised by the Dead Weight Ton (DWT), i.e. the total weight or mass of cargo, fuel, fresh water, ballast water, provisions, passengers and crew (see Table 1). Larger tankers usually carry crude oil while smaller tankers are used for refined petroleum products. Tankers of less than 100,000 DWT can transport both crude oil and petroleum products [3]. Oil tankers have usually a diesel propulsion system. The specific fuel consumption depends the oil tanker size; larger ships use less fuel per ton-km compared to smaller tankers. Specific fuel consumption and CO_2 emissions for various oil tanker sizes are shown in Table 2; a tanker above 200 kDWT consumes 42% less fuel per ton-km compared to a tanker between 75 and 120 kDWT. The annual availability of an oil tanker depends on speed, loading and service time. A typical speed for an oil tanker is 14 knot = 7.2 m/s [4]. Loading and unloading takes typically 24 hours [5]. The average productivity of tankers, given as tons of oil carried per DWT per year, has decreased from 7.7 ton per DWT\y in 2000 to 6.7 ton per DWT\y in 2008, with 7.1 and 7.5 in 2006 and 2007, respectively [6]. The average age of the oil tankers has also decreased over the past decade. In general, it is higher in developed countries

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