Summary

Due to the climate change problem and the fast decreasing amount of remaining fossil fuel reserves, energy efficiency has become an important issue. Emission standards have become more strictly and fuel consumption has become an important criterion in engineering. As a result, developments over the last couple of years have created new engine technologies that increase energy-efficiencies and reduce emissions.

In port areas, a large amount of diesel powered, heavy-duty equipment is operational for thousands of hours per year, and as a result, the pollution levels and energy consumption in port areas are relatively high. Reducing the fuel consumption and emission of this equipment will therefore have a positive influence on local air quality and global environment.

The goal of this literature study is to make an overview of alternative, energy efficient transport systems for the Port of Amsterdam.

In Chapter 2, a comparison has been made between the total emissions of diesel trains and electric trains based on given railway traffic data from the Ceres Paragon container terminal. As electric trains are not driven by combustion engines and produce no noxious exhaust gases, the amount of direct emissions is zero. This means that the use of electric trains has no impact on local pollution levels, and is therefore harmless to residents of the environmental urban areas. However, global pollution is caused by the indirect emissions. Indirect emissions are produced during the generation of the required electricity in the electricity plant, elsewhere. The use of electric trains therefore may be harmless to local environment, but in fact the noxious gases are emitted elsewhere. Hence, the pollution has shifted from a local issue to a global issue.

The comparison will show how large the difference between electric trains and diesel trains actually is. Based on data from 2005, the advantage of electric trains is significant: 20% less emission of carbon-dioxide (CO_2), 62% less emission of sulphur-dioxide (SO_2), 91% less emission of particulate matter (PM_{10}) and 94% less emission of nitro-oxides (NO_x). Besides a difference expressed in terms of percentage, the difference is also expressed in the number of trucks required to produce an equal amount of exhaust gasses.

At the Waterland terminal, heavy-duty semi-trailer diesel trucks are driving up and down the terminal from the quay to the warehouse, which is located directly behind the terminal. This short range forces the trucks to accelerate and decelerate continuously, which has a negative influence on fuel consumption and emission levels. Chapter 3 describes three different types of alternative, energy efficient trucks that could replace the trucks that are currently being used: electric trucks, hybrid trucks and LNG trucks that are powered by Liquefied Natural Gas. Electric trucks have by far the lowest emission levels, since they produce no direct emissions at all. Emissions produced by generation of the required electrical energy are however not included, but it is assumed that this will not affect this result.

In Chapter 4, three different types of container handling equipment are regarded: Rubber Tyred Gantries (RTG's), Straddle Carriers (SC's) and electric forklift trucks. Especially the rubber tyred gantries have been subject to innovation, considering the relatively large number of energy-efficient RTG's that have been introduced lately. The most energy-efficient type of RTG's are the mains powered RTG's and the hybrid RTG's equipped with a supercapacitors based energy storage system. Both can reach a reduction of energy consumption of up to 70%. With the mains powered RTG producing no direct emission, this is also the cleanest type, reducing emissions by up to 90%. Besides these RTG's, this chapter will describe the latest innovations on Straddle Carriers and electric forklift trucks, reducing fuel consumptions by up to 60%.

In Chapter 5, the latest innovations in bulk terminal equipment will be examined. The types of transport systems regarded are wheel loaders, bulk cranes and belt conveyors.
In 2009, Volvo will start deliveries of the world's first hybrid wheel loader, which will be able to save up to 10% of fuel compared to the all-diesel powered model.
The chapter also describes the demonstration project currently going on at Maja Stuwadores in Amsterdam and Rotterdam. At these terminals, bulk cranes are equipped with new flywheel technology, an energy storage system which is expected to reduce the fuel consumption by 30 to 40%.
The last part of this chapter is dedicated to variable-speed conveyor belts. As conventional conveyor belts are mostly equipped with a fixed-speed generator, large amounts of energy are wasted when conveyor belts are not fully loaded. Belt conveyors equipped with a variable speed drive automatically adjust the speed of the electric motor to the load on the belt, while saving energy. A worked out example shows that for a given variable-speed conveyor belt system, the energy savings for the transportation of a load that is only 10% of the maximum belt load could be up to 82%.