

Shipping Infrastructure

HIGHLIGHTS

■ **TECHNOLOGY STATUS** – Ships have the largest carrying capacity of any freight mode and maritime ports handle more freight than all other types of terminal combined. Thus, shipping infrastructure requirements are substantial. The infrastructure elements include port terminals (docking areas, bunkering, shore-side power, storage); port operational equipment (cranes, tugboats, dredgers) and man-made global maritime routes. Port terminals usually provide specialised facilities (cranes, grabs, storage) for different types of cargo. *Containerization* of cargo has revolutionised the industry, drastically reducing labour requirements - by almost 97% for a modern containership compared to *uncontainerised* cargo. Technology options to reduce the energy consumption and GHG emissions from port infrastructure and operations include the use of alternative fuels, fully electric port equipment (e.g. cranes), port-side electricity supply (cold-ironing) and hybrid or re-engineering of tugboats and dredging vessels.

■ **PERFORMANCE AND COSTS** – The construction of port facilities constitutes a minor percentage of lifecycle energy use and CO₂ emissions (<1%). The cost of adding shore-side electricity supply infrastructure is estimated to range between US \$1 million and \$7 million per berth, with typical in-dock CO₂ savings of around 50% over running conventional ship diesel engines, and associated fuel savings. Emission reductions can also be achieved for port operational equipment by switching to alternative fuels (e.g. biodiesel), fully-electrified equipment or through operational means. Modern full-electric cranes can recapture 75-80% of the energy released when a load is lowered. Simultaneous operation of many cranes can deliver savings of up to 30%, while synchronising movements can realise an additional 5% energy saving. Tugboats can be retrofitted with pollution control devices or use cleaner alternative fuels. Electric-hybrid tugboats are just entering the market, with reported CO₂ savings of 27% over conventional types. Dredging consumes between 2270 and 2680 litres of diesel per hour. Abatement options for dredging vessels include alternative fuels and upgrading engines. In order to handle the growth in the number of transits and vessel sizes, several expansion works are underway for global maritime routes, e.g. a project is currently underway to double the capacity of the Panama Canal.

■ **POTENTIAL AND BARRIERS** – In 2009, global seaborne trade volumes contracted by 4.5% due to the economic recession. Total goods loaded fell from 8.2 billion tons to 7.8 billion tons. With the exception of major dry bulks (coal, iron ore), all shipping segments were negatively affected. The economic recovery is expected to bring renewed demand for seaborne trade, although the fragile financial position of some advanced economies is a source of uncertainty. Sea ports and global maritime routes are experiencing greater pressure from larger container ships, which require bigger capacities, larger storage areas, specialized cranes and dredging at increased frequencies and depths. The future is expected to bring progressively more stringent limits on CO₂ emissions from ships in port, increased taxes on pollution sources and tax incentives for shore-side power. Emission reductions for port operational equipment are subsidised by several programmes in the US, which have encouraged greater penetration of efficient engine technology. Uptake of renewable generation technologies in ports is gaining greater interest, for example wind power and solar energy.

TECHNOLOGY STATUS - This brief outlines energy consumption, greenhouse gas (GHG) emissions and costs arising from construction, maintenance and operation of shipping infrastructure. Ships have the largest carrying capacities of any mode. For instance, a typical barge has a capacity of 1,500 tons, which is significantly greater than that of a semi-trailer truck (26 tons) or a 747-400F aircraft (124 tons). A VLCC (very large crude carrier) has a capacity of up to 300,000 tons, whereas a 100 car train unit can carry up to 10,000 tons [2]. Due to these large carrying capacities, infrastructure requirements for maritime vessels are substantial. They can be broadly categorised as:

- Port terminal infrastructure - static structures such as buildings, docking areas and power supply;
- Port operational equipment - vehicles or machinery needed to provide port services including towing, cargo handling and dredging; and
- Global maritime routes - man-made passages which are vital to international trade.

Port facilities are determined by the type of cargo they handle. **Liquid bulk** cargoes, such as crude oil, are

moved using pumps and pipelines; they require only limited handling equipment but may need significant storage capacity. **Dry bulk** products are unpackaged goods such as ore, cereals and coal. Sophisticated equipment is used to handle these goods such as cranes, specialized grabs and conveyor belts. Some terminals have specialized storage structures such as grain silos or refrigerated warehouses. **General cargo** requires a lot of labour to handle because dimensions and weights are not uniform. Containerization, which allows mechanized handling, is becoming progressively more common. **Container** terminals have minimal labour requirements, but generally require large amounts of space for moving and stacking containers. The larger the containerships handled by a port, the larger the required storage area. Intermediate or **transshipment ports** are used for ship-to-ship operations; containers must be stored in the port temporarily, rather than being transferred directly. Their importance is growing as they increase connectivity between global ports.