



Co-financed by the European Union
Trans-European Transport Network (TEN-T)

SEAterminals

ELECTRIC TERMINAL TRACTOR PROTOTYPE

PROTOTYPE DESCRIPTION

The full Electric Terminal Tractor designed by Terberg in the framework of the European project SEA TERMINALS has been conceived for moving trailers in container terminals, distribution centres, transport depots, etc.

The spacious and comfortable driver's cab offers excellent visibility and has an inboard door for safety and convenience.

Fully electric drive means the vehicle is economical to operate and does not lead to emissions at the point of use. The electric motor requires much less maintenance than a diesel engine and is quieter.

OBJECTIVES

The objective of this SEA TERMINALS prototype is to significantly reduce GHG and pollutant emissions on port areas by introducing electrification technology in port yard trucks, a vehicle typically powered by diesel fuel.

The benefit of using electricity as main energy source is the decarbonisation of port operations as a typical fleet of 60 yard trucks can generate around 5,000 CO₂ tonnes yearly with a consumption of around 2 million litres of diesel fuel per year in a single port container terminal.



ENGINEERING PROCESS

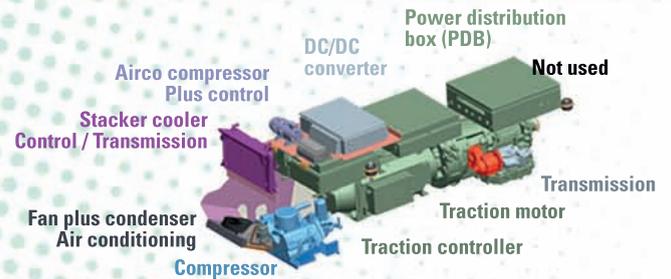
ENERGY STORAGE

The dimensioning of the energy storage system is of essential importance for the vehicle concept, as this determines its availability. For the prototype the objective is to allow an operating time of 8 hours, which is the equivalent of one shift.

The complete battery packs consist of:

- Two batteries packs each containing 2 layers
- 8 Battery management modules (BMS):
 - Checking individual cells on load and temperature
 - Control power flow in and out of power pack
 - Levelling cells: bleeding
 - J1939 interface to other controls
- Total of 92 battery cells
 - 21 kg each
 - 2.8-4.0 Volt
 - 700Ah

Charger Capacity	Charger Output	Charger Input	CEE Form	Charge Time
40 [kW]	133 [A]	57 [A]	63 [A]	4 ¼
60 [kW]	200 [A]	85 [A]	125 [A]	3
80 [kW]	266 [A]	114 [A]	125 [A]	2 ¼



DRIVE LINE CONCEPT

Engineering challenges for the driveline is covering the tractive effort plus needed speed. Based on several assumptions the decision was made to use a transmission for grade-ability and speed purposes. An additional advantage of the transmission is the PTO which allows an hydraulic pump. The hydraulic pump driven by the traction motor eliminates the need for an additional drive for an electric motor for the pump.

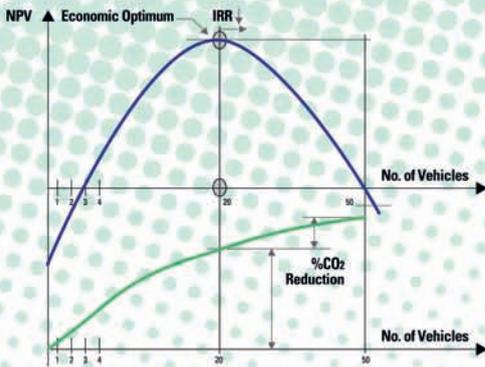
March 2014

Theory and Modelling

February 2015

Electrical Terminal Tractor Simulation

August 2015



The previous figure shows an example of the single-variable vehicle fleet investment model used. In the case displayed, the NPV maximum is reached when the number of vehicles is 20. Investing in more than 20 vehicles will make the IRR decrease.

The environmental optimum does not coincide with the financial optimum though. The environmental optimum will be reached when the whole fleet is replaced (50 units) as this is the point that minimizes emissions.

However, it needs to be born in mind that a private company will always invest aiming at maximizing profitability and therefore their decision may not minimize emissions. For the environmental optimum to be reached, incentives may be necessary.

Following the project methodology, a simulation of the replacement of the terminal tractors fleet was run.

The proposed feasibility model provides the differential cash-flow of the investment evaluated for the replacement of diesel terminals tractors by electrical machines.

The input data are the variables presented as well as the demand distribution of the terminal. With this information the cost-benefit model evaluates the profitability of the investment by means of the calculation of three variables: Net Present Value (NPV), Internal Rate of Return (IRR) and Investment Payback.

The model is flexible and it allows different configurations. For the purpose of evaluating the terminal tractors fleet, it is adjusted to an investment horizon of 15 years, which represents the concession remaining time of Noatum Container Terminal Valencia at the Port of Valencia.

The full electric Terminal Tractor prototype developed by Terberg offers the same functional structure than diesel machines, although some variations must be taken into consideration:

Infrastructure

Grid must be adapted to support charge stations for full electric vehicles.

Workshop

To work on high Voltage vehicle's, employees must be trained and certified.

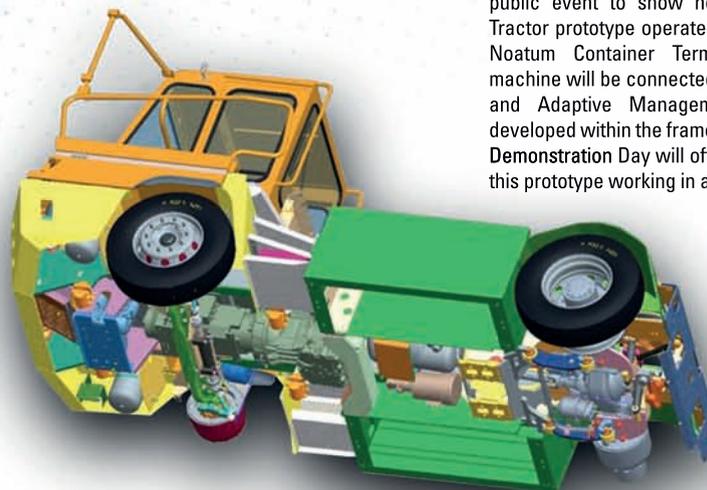
Tools and workshops should be adapted for safety reasons.

Planning

Charging vehicles takes few hours and this has to be considered for planning operations, which can also affect vehicle availability.

Pilot and Public Demonstration Day

The Public Demonstration Day will consist in an open and public event to show how the full electric Terminal Tractor prototype operates under real port conditions at Noatum Container Terminal Valencia (Spain). The machine will be connected to the Smart, Energy Efficient and Adaptive Management System (SEAMS) also developed within the framework of SEA TERMINALS. The Demonstration Day will offer a unique opportunity to see this prototype working in a real life scenario.



SEA TERMINALS PARTNERS:



BPO
BALTIC PORTS ORGANIZATION

OLT

ALFA ROMEO

Global Service Srl

Scuola Superiore Sant'Anna

IMPLEMENTING BODIES:

