PLUG : the shore power solution you can afford!

Damien FEGER[1]

[1] NG3, www.NG3.EU

Abstract

Shore power is one of the numerous technical solutions available to reduce shipping local and global emissions. Presently, it has only been implemented on a case by case basis, due to local initiatives from Port authorities, on around 100 vessels worldwide.

In most of these cases, priority was to find a solution within a relatively short schedule. This has driven the choice towards the adaptation of ”off the shelf”, technical solutions, rather than developing innovative technologies to provide a fully optimized solution in terms of expenses, as well as operational constraints and safety.

Therefore, shore power may be rejected as being unacceptable in terms of cost, or even worse, operations and safety.

PLUG (acronym for “**P**ower **G**eneration during **L**oading & **U**nloading”) is addressing this challenge with a unique self mating / de mating high voltage connector which allows a cost effective and safe connection.

Based on this, PLUG is expected to reduce shore power capital and operational expenses connections to a third of present state of the art solutions…

The paper presents:

- Cold ironing specific requirements and constraints;
- PLUG key features;
- A focus on its potential implementation for Singapore Container carriers and terminals.

Combined with the upcoming Jurong LNG receiving terminal, PLUG technology could provide a profitable way of reducing shipping emissions in Singapore.

Keywords: Shore power, Port Emissions reduction, Cold ironing, HVSC

1 Introduction

Ideally, as illustrated in Fig 1, shore power could become a fully optimized extension of the shore power network towards the vessels at berth, both in economical and environmental terms, by allowing ships to get connected to lower emissions, lower costs power sources.

Taking advantages of present day IT technologies and that efficient power exchange trade market are already in place in many countries to allow to trade power just one quarter of an hour ahead, shore power could become a real time optimization of the balance between supply and demand….

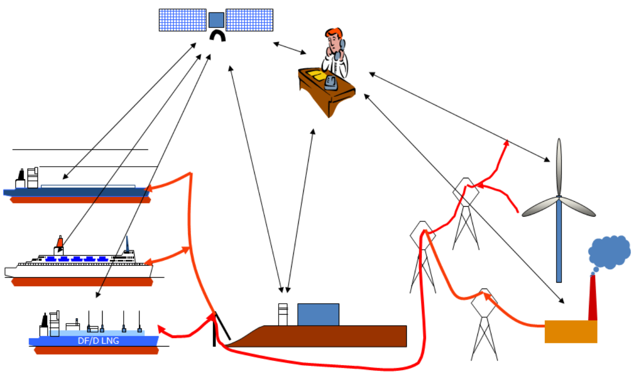

Fig. 1 The Shore power concept

2 Cold ironing requirements and constraints

Fig 2 illustrates the possible strategies ship owners could have on this market, taking into account the typical, intrinsically, hour by hour, week by week, fluctuating price of the on shore power market.

Compared to shore power market price, on board generation cost is remarkably stable on a daily basis, as it is mostly driven by the cost of the fuel and maintenance of the on board gensets (although this may vary depending on the power load and the corresponding engine efficiency), and has been illustrated by a flat line on this figure.

As an example in this figure, we have set this on board generation cost line in the middle of the typical hourly shore power market price. This means that during the day peak hours, when demand by other (shore based) consumers is high, shore power price is significantly higher than on board generation, and that a ship owner's interest is to keep his gensets running…and even sell power to the network! On the opposite, during low demand period, typically at night, his interest is to switch to shore power to get access to lower cost sources of energy…

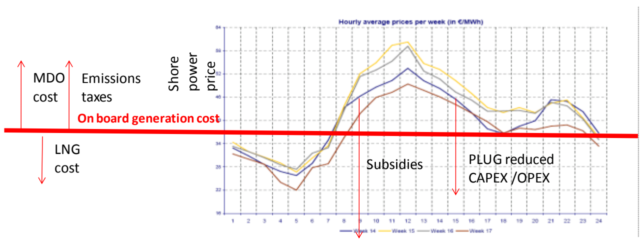

Fig. 2 Typical shore power economics

In this case, a shore power connection becomes an attractive way to play, and most importantly, beat, the shore power market, by getting connected only when it is profitable…Some vessels , like Diesel Electric LNG carriers, could even play the market both ways, using their main propulsion Gensets to sell power to the shore

during peak hours (Feger et Al 2008).
Unfortunately, in most cases, shore power is not profitable for ship owners, and hardly a couple of hundred are using it during their normal operations, a clear indication that this is not a profitable operation….In fact, while reviewing CO2 emissions (and fuel consumption) reduction strategies Det Norske Veritas class society recently ranked shore power as one of the least efficient CO2 emissions abatement technologies, behind no less than 20 others!, see Fig 3 (Det Norsk Veritas 2009). Nevertheless, several factors, beyond mandatory requirements, may change shore power use, as identified in Fig 2:

1) On board (Diesel) generation fuel costs may rise sharply compared to shore generation resources in the coming years, both if oil barrel price rises and if, as it is already the case in some areas, use of low sulphur fuels becomes mandatory (Notteboom et Al, 2010);

2) On board generation price may as well increase if local or global emissions taxes are implemented;

3) Subsidies, especially to cover the initial ship owner's and terminal' s Expenses may be implemented (and has been in most present cases), but cannot be considered as a long term, widespread, solution;

4) And last, and by far, not the least on the long term, the shore power industry can increase its competiveness by reducing, through innovation and other cost abatement measures, its Capital and Operational Expenses, as NG2 is proposing with its PLUG connector solution….

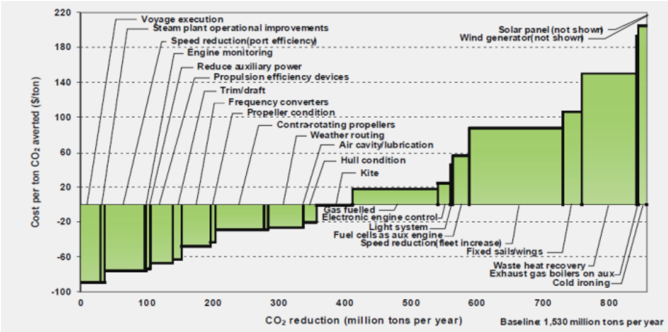

Fig. 3 Benchmarking between CO2 emissions abatement solution(Det Norsk Veritas)

2 PLUG key features

PLUG proposes a game changing technology based on a very innovative connector system, leading to much easier and efficient operations:
As soon as the vessel is secured alongside the quay, the crew has just to slide out above the quay a beam to which is attached the ship side power socket and drop a chain toward the quay side connector.
The chain is equipped, see Fig 3, at its end with a triangular cross section "shuttle bar", which as soon as it is inserted into the quay side connector. Getting further down, inside the connector, the shuttle bar gets into contact with a set of three rollers which force it to rotate and get indexed with the connector electrical contacts, and gets into a mechanism which locks it with the connector.
The crew can hoist up towards the ship side socket the quay side connector and the power cables attached to it (see videos on NG2 website…).
When it gets into the ship side socket, the shuttle bar is guided by another set of three rollers and rotates again to align in front of each others the connector and socket electrical contacts.

Fig. 3 PLUG connector guiding system

When the connector gets further up, the socket electrical contacts push open the quayside connector contacts and the connection is established.

These unique features, make PLUG the world first solution to perform a safe, multi mega watt, high voltage, connection in less than a minute…!

Another features is that PLUG fully mechanized operations are insensitive to the mass and (lack of) flexibility of the connectors and cables: the power exchange capability can be optimized to meet with the same design, and a single PLUG unit, most of the world's fleet requirements, under up to 11 000 Volts.

Fig 4 shows the typical ship side and shore side PLUG deliverables.

One of the big benefit is, from ship side point of view its compactness and limited part lists, to which benefits a negligible quay side footprint, is to be added.

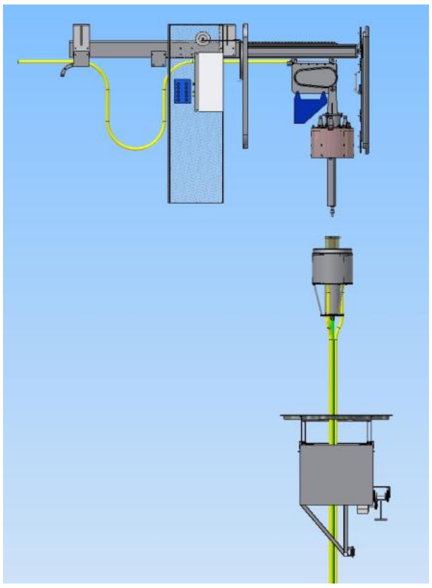

Fig. 4 PLUG typical deliverables

Taking advantage of this ship side interface compactness, we propose to install it, see Fig 5, within the side passageways which are fitted along container carriers above the side ballast tanks, preferably at the level of the Engine room main switch board, to reduce the length of the routing of HV cables between PLUG and the vessel's main switchboard, reducing installation costs and duration..

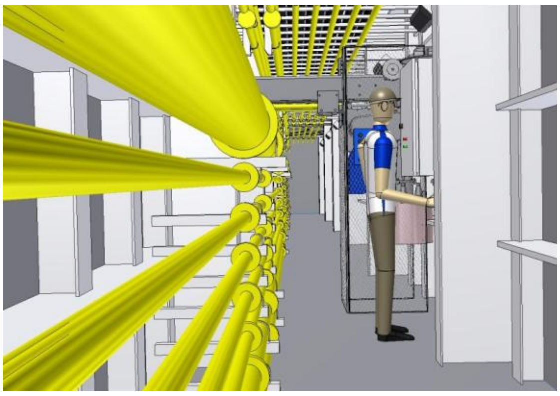

Fig. 5 PLUG typical implementation on board container carriers

Operationally, this could mean, as well, that the PLUG operations could be directly performed by the crew member on watch at the nearby main switchboard. Alternatively, if an optional camera is installed on the ship side unit, the whole operation could even be performed by the officer in charge of the mooring operations, using a video screen installed on the bridge wings!

On the terminal side, see Fig 6, the PLUG interface will be a sliding basket located just above the water alongside the quay, so that the HV cables can festoons under it under the water. Although rudimentary, this is very cost effective and reliable cable storage and management system, taking advantage of the available volume created by the quay side fenders between the quay and the vessel sides!

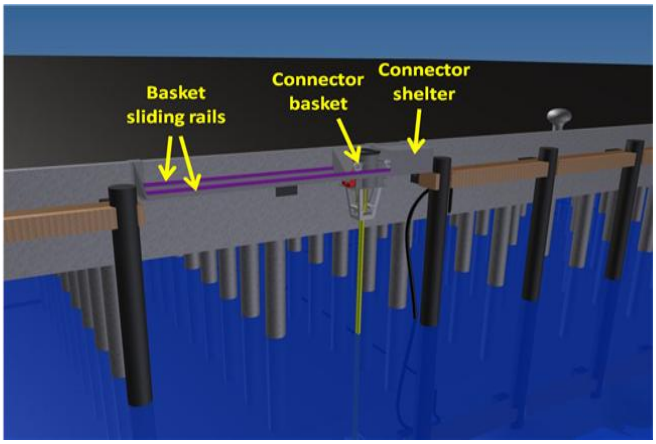

Fig. 6 PLUG typical quay side implementation

PLUG has been officially released on the market at the September 2010 Shipbuilding, Machinery and Marine technology fair in Hamburg, where a full size PLUG was on display),see Fig 7, demonstrating , among other features,its one minute connection/disconnection capability.

Fig. 7 PLUG full size demonstrator

3 Possible implementation for Singapore

To build the shore power container carriers terminals case for Singapore container terminals, one has to overcome three deadlocks:

1) to have enough competitive and possibly greener shore power sources available to meet the corresponding demand;

2) to be able to provide 60 Hz power, which is standard for most containers carriers;

3) to offer a cost effective operations.

For the first one, Singapore has a major trump card with its future LNG receiving terminal, as this will give access to Natural Gas at a very competitive cost to provide the required power, benefiting both from its lower emissions and its long trend cost advantage against oil.

Assuming that on average the ships calling at the 60 to 70 berths available both at Singapore and Jurong facilities, will require 3 MW of power each and, that at a given time, 80 % of the berth will be occupied, the required power would be in the range of 150 to 200 MW. This would require to dedicate one or two Combined Cycle Gas Turbine plants to provide the required power. These plants could be linked to a dedicated shore power network and would operate at 60 Hz frequency, solving the frequency deadlock.

We dare to state that with PLUG, the third deadlock is suppressed.

So, by setting up such infrastructure and taking advantages of access to LNG at a competitive price, Singapore State and Port Authorities could set up a shore power value chain which would be beneficial, both in terms of local and global emissions, but as well, in economical terms for both the port and ship owners.

5 Conclusions

Like most other emissions abatement strategies, shore power is facing an economical challenge, but in many cases, it may bring the opportunity to tap in not only greener, but most importantly, lower cost, sources of energy , such as hydro, nuclear, gas, or although on a longer term wind or solar… The possibility to develop the corresponding business case with a satisfactory added value for all the stakeholders involved will, therefore, first depend on the availability of such lower cost and greener power. If this is available, the next item would be to provide shore power at the appropriate frequency, and this may require, in countries like Singapore, to build up a dedicated power infrastructure. This, combined with the use of PLUG technology which drastically reduce ship owners and terminal operators expenses, while increasing the whole operation return on investment should make shore power economically attractive, in particular in Singapore by taking advantage of the implementation of a new LNG receiving terminal.

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