Shipping Electrification:
Turning the Zero Emission Vessel into a Short Sea 'bridge'

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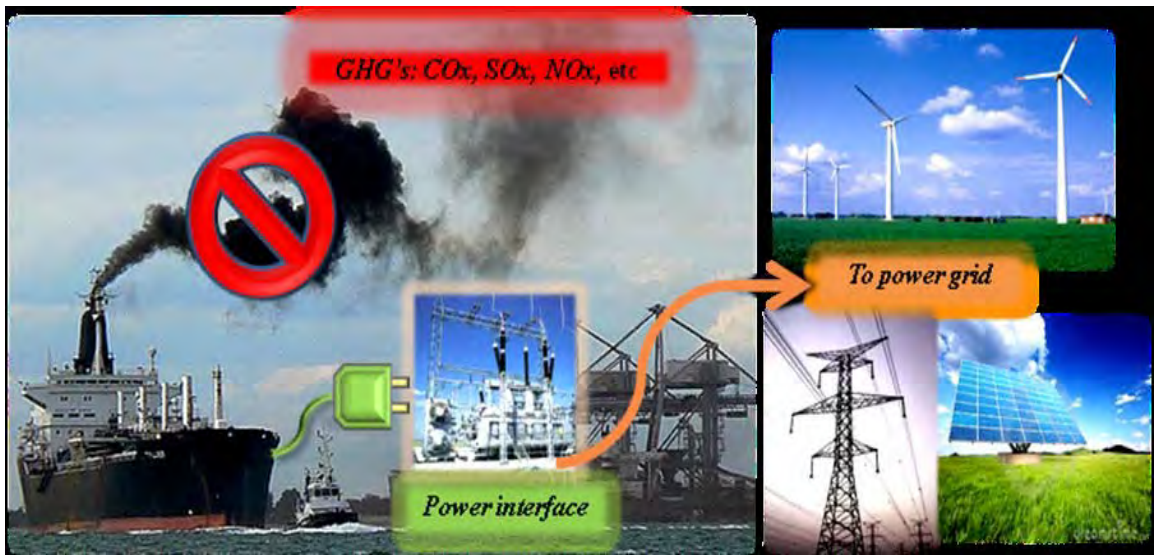
Cold Ironing – First Step to Electrification



Air emissions produced during the stay of vessels at port have the most significant impact on **public health** due to proximity to densely populated areas

Cold Ironing (or alternative maritime power - **AMP**) is the process of providing shore side electrical power to a ship **at berth** while its main and auxiliary engines are **turned off**

Challenge + Target ⟹ Development & use of **renewable** energy sources

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Electric Bunkering – Energy Storage onboard

Electric Supply from shore is used to 'charge' the vessel's Energy Storage System **ESS**.

Stored power is then used to provide the entire or partial propulsive power required in short sea distances

Challenge + Target ⟹ Development & use of **renewable** energy sources

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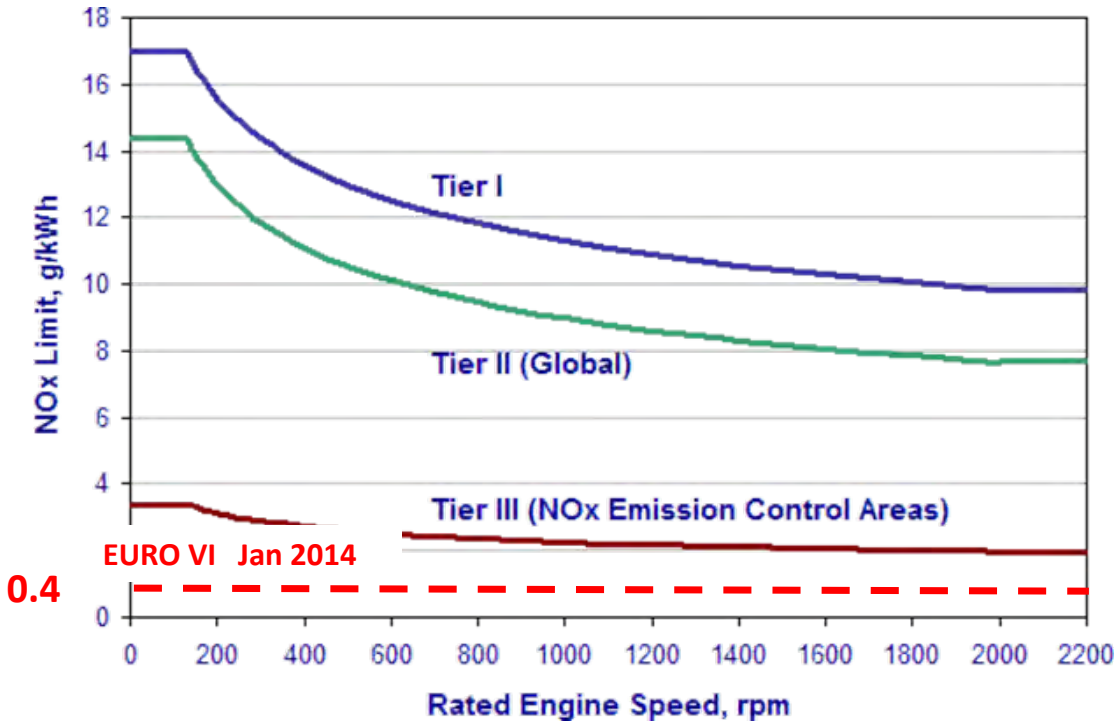
Societal & Environmental Benefits

- Amelioration of **public health** & **environmental protection**
- Reduction of **air emissions** in the ports surrounding areas
- Reduction of **noise and vibrations** from ships at berth
- Upgrading of the **quality of life** with prospective **growth** in other sectors: trade, tourism
- Alignment with **EU directive** for **SOx** emissions (2020) and potential upcoming directives for **NOx** emissions
- Alignment with International goals for air emissions (**Paris Agreement 2015** – COP21)
- Evolution of **sustainable connectivity** and support of **insular communities** of the Archipelago

Societal Cost – The NOx Case



- **Nox is the most lethal emission to human beings**
- **Despite the avalanche of Regulations little is done for our area**
- **Cruise in port of Piraeus may easily exceed 50 MW in power in standard days**

Cold Ironing is the quickest way to solution as it takes combustion away from densely populated areas

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Financial & Operational Benefits

- Exploitation of **low-carbon electric energy** generated by **inland power stations**
- Promoting commercial implementation & **port competitiveness**
- Preparing ports for use of **alternative energy sources**, Ports connection to **Smartgrid**
- Preparing ports for accommodation **electric/hybrid ships**
- Boosting sustainable shipping with emphasis in **short and mid-range mobility**
- Introducing **zero emission solutions** and blending the **renewable energy** with the **shipping** sector
- Revival of the **local ships construction** activity
- Boosting **growth** by accelerating technology uptake
- Making **island mobility** realistic and sustainable

Regulatory Framework – Key to success

- Electrification should be treated as one infrastructure
- Flexible framework is needed in order to allow significant investment as well as local community engagement
- Electric supply for Marine use is practically green energy *(On the basis of emissions differential)
- A robust regime for incentives should be in place
- Public Private Partnership and local community required to leverage the investment

Shipping could explore ways to make good use of the electricity production by-product in the same manner it has done so far for the oil refinery industry

Global applications

Now the biggest ports in West Coast apply the Cold Ironing Method: Los Angeles, Long Beach, San Francisco, San Diego, Seattle with impressive results in air emissions reductions in ports nearby areas

Americas

- North America - pioneer in Cold Ironing
- Alaska - Juneau success story)
- LA/California: the most sustainable and cost effective way to reduce shipping emissions pollution

Global applications

Report

Göteborg Hamn leading the world's port business to ecology

Cold ironing can reduce air pollution and noise at the port

Photo: Port of Göteborg

Nowadays we are accustomed to pay attention to reducing air emissions from power stations, factories and cars.

shore during their stay in port enabling their auxiliary engines to be shut down and not use fuels to run necessary operations. Today

Report

tions already existed for ferries. The source of shore-side electricity is also environmentally friendly – the Port of Göteborg uses renewable energy sources such as wind power.

It takes 10 minutes

"Cold ironing" gives the best results in the ports where specific vessels (with appropriate installation onboard) frequently arrive and stay for a longer period of time. General principles for modern high-voltage systems can be seen in the Figure 1.

The ship is connected by a high-voltage cable to the shore-side electrical connection point. The power is distributed to the connection point from the local high-voltage sub-station. The high-voltage cable allows transferring 25 times more power than a standard 400 V cable of the same dimension. It takes 10 minutes to connect the ship to the shore-side installation and to switch off the auxiliary engines. The exception is during bunkering operations when the auxiliary engines are run for safety reasons. High-voltage power (6-20 kV) is easily available when a quay is located close to a residential or industrial area. In the case of Europe almost all ports have high-voltage electricity available nearby. And, what is needed onboard a vessel? An entrance for connecting a cable, a socket for the cable and the transformer (preferably located near the main switchboard in the engine room) which transforms high-voltage power to the 400 V power used on the ship. There are some parameters that must be taken into consideration when discussing the system's costs and requirements:

- shore-side frequency (50 Hz in Europe),
- onboard frequency (50 or 60 Hz),
- shore-side supply of high-voltage electricity (voltage, distance to the nearest supply point and installation practicalities),

Fig. 1. Shore-side, high-voltage power installation.

Port of Göteborg started to supply low-voltage shore-side power to ferries.

Vessels are the main source of SOx

The costs of supplying high-voltage power at the quay-side may vary greatly as it depends on the distance to the nearest high-voltage supply and other local conditions. In spite of this, several independent studies have shown that costs (total costs for society) of onboard power generation are much higher than the total direct costs for the ship-owners and the ports. The cost of electricity in Europe is high, but it may be lowered for "cold ironing" purposes if there is a tax exemption. Due to the fact that fuel prices with a low sulphur content are rising, "cold ironing" will still allow significant savings. Many organizations, like the Port of Göteborg together with Stena Line, the

European ports by the example of Lübeck-Travemünde. The parties involved were Lübeck's municipal utility and GAUSS mbH (Environmental Protection and Safety in Shipping company). The project examined the effect of emissions from different sources in the Lübeck-Travemünde area and analyzed what could be done to reduce emissions. Research showed that ships and ferries are the main source of sulphur dioxide and nitrogen oxide emissions and "cold ironing" is the most favourable solution.

Honours for the Port of Göteborg

Until now, thirteen ports from all over the world have implemented the idea of shore-side electricity. In July they will convene at a conference in Rotterdam to sign a climate declara-

EUROPE

- First in Sweden, Germany, Belgium, Norway, Netherlands
- Passenger ships mainly
- Recently Finland for Viking Line ships

Princess Cruises and Carnival Group full deployment of Cold Ironing in the fleet

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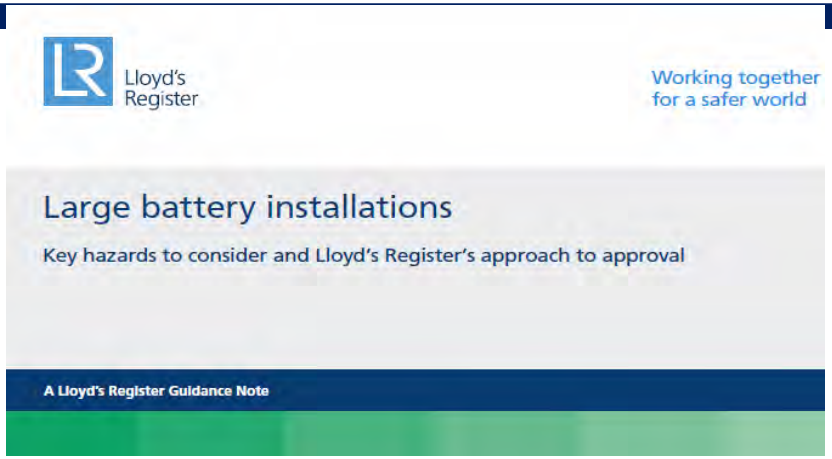
New technology – New guidance

LR has issued its first guidance on battery installations, 2years ago. A fresh update is now available

This addresses the risks and hazards associated with the use of batteries and aims to ensure safe and efficient applications



LR OPS Notation is there to ensure cold ironing is implemented safely onboard

Engine Manufacturers including Wartsila have already developed new technology & **concept designs** for zero emissions

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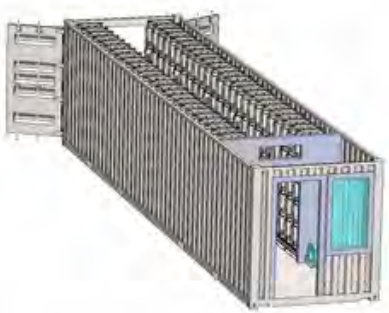
Wide range of solutions readily available

40' Container Configuration



- Battery Only, 1365 kWh
- Battery & Power Electronics, 819 kWh

- **Remote charging**
- **Containerised ESS**
- **ESS and Energy Recovery Systems**

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LR Hybrid Electric Ships

LR has an extensive

- nearly **20-year** - experience of **battery installations** on board ships and yachts

Ship name	Ship type	Year of build
Savannah	Yacht	2015
Hybrid III	Passenger/ro-ro ship	2015
Perentie	Tug	2015
Euro	Tug	2014
Dugong	Tug	2014
Boodie	Tug	2014
RT Emotion	Tug	2014
RT Evolution	Tug	2014
Lochinvar	Passenger/ro-ro ship	2013
Hallaig	Passenger/ro-ro ship	2013
Rainbow	Yacht	2012
RT Adriaan	Tug	2010 (hybrid retrofit 2012)
Deutschland	Passenger/ro-ro ship	1997
Prinsesse Benedikte	Passenger/ro-ro ship	1997
Schleswig-Holstein	Passenger/ro-ro ship	1997
Prins Richard	Passenger/ro-ro ship	1997

Benefits of battery systems:

- Potential for optimised engine operation
- Reduced fuel consumption
- Safety and reliability
- Agility

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MV Hallaig: Calmac's first Hybrid Ferry

the **world's first** sea-going roll-on roll-off vehicle and passenger **diesel-electric hybrid** ferry

incorporates a **low-carbon hybrid system** of **diesel electric** and **lithium ion battery** power

developed under the Low Emission Hybrid Ferries Project

more than **£20m** of Scottish **government investment** created **175 jobs** and **20 apprenticeship** positions for the local community

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The Innovative **Texelstroom** TESO Ferry

Advanced energy management system – operating principally on **gas** but also with **batteries**, **solar** auxiliary power and the capability to run solely on **diesel**

Two completely independent **engine rooms**
Two ABC **diesel** engines (2 x 2000 kW),
Two ABC **dual fuel engines** (also 2 x 2000 kW)
Operates mainly on **natural gas** stored in **two Batteries** of **CNG** bottles installed on the top deck
Over **700m² of solar panels**
Ice class

combines the innovative use of several different energy sources to provide reliable, efficient power and vastly reduce **environmental impact** in comparison with existing ferry technology

Design supported by the **EU 'I.Transfer' Program** for more freely accessible and sustainable ferry transport so to encourage more people to travel by water

Initiation of a **community engagement** exercise focusing on (1) on board power consumption **savings** (2) reduced power generation **emissions** (3) reduced **wastage** in other shipboard system

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Svitzer ECOtugs

Four new LR classed **ECOtugs** –hybrid vessels that operate **exclusively on battery power**, while maintaining full **manoeuvrability**

33m long, 13m beam diesel-electric tugs with an impressive 75t bollard pull
electrical deck equipment
low-reflection paint
double wall fuel tanks
solar panel water heating
on-board water recycling

perfectly suitable for operations in one of Australia's most **environmentally sensitive** regions

technology that reduces **noise and light emissions** thus minimise the impact that the tug operations have on **sea life**

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Take Aways

- ✓ Electrification driver for growth in two fronts, Cold Ironing , Hybrid vessels
- ✓ Promising alternative for Archipelagic States like Greece
- ✓ Key to port competiveness and establishment of the Cruise Industry
- ✓ Boosting labour intensive activities like shipbuilding
- ✓ Key to extrovert ship construction activity
- ✓ Rendering local island mobility a reality
- ✓ Introducing maritime transportation to the zero emission era
- ✓ Bridging Islands but also the renewable energy sector to propulsion

Need for a robust modern framework to upsurge investment and applications

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Working together for a safer world