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COLD IRONING

Clean Energy for Sustainable Ports

Bilbao, September 20th 2017

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1. Introduction

COLD IRONING, what and why?

- *Cold Ironing* is a port facility to plug ships at berth into the shore-side grid enabling to switch off on board auxiliary generators.

- ***Cold Ironing* cuts to ZERO local emissions, noise and vibration.**

- Transferring power from on board generator to shore supply is made safely with automatic synchronization and without disconnecting ship loads.

- 100% of the ship power demand at berth must be supplied, including hoteling, HVAC, loading/unloading operations, reefers etc.

- Other names that are used for the same technology: *Shore Connection*, *Shore-to-ship Power*, *Shore-side electricity*, *On-shore Power Supply*, *Alternative Maritime Power*.

How much does a ship at berth pollute ?

Cruise consuming 7 MVA at berth pollutes as much as 9.000 (of NOx) or 3.000 (of PM) cars

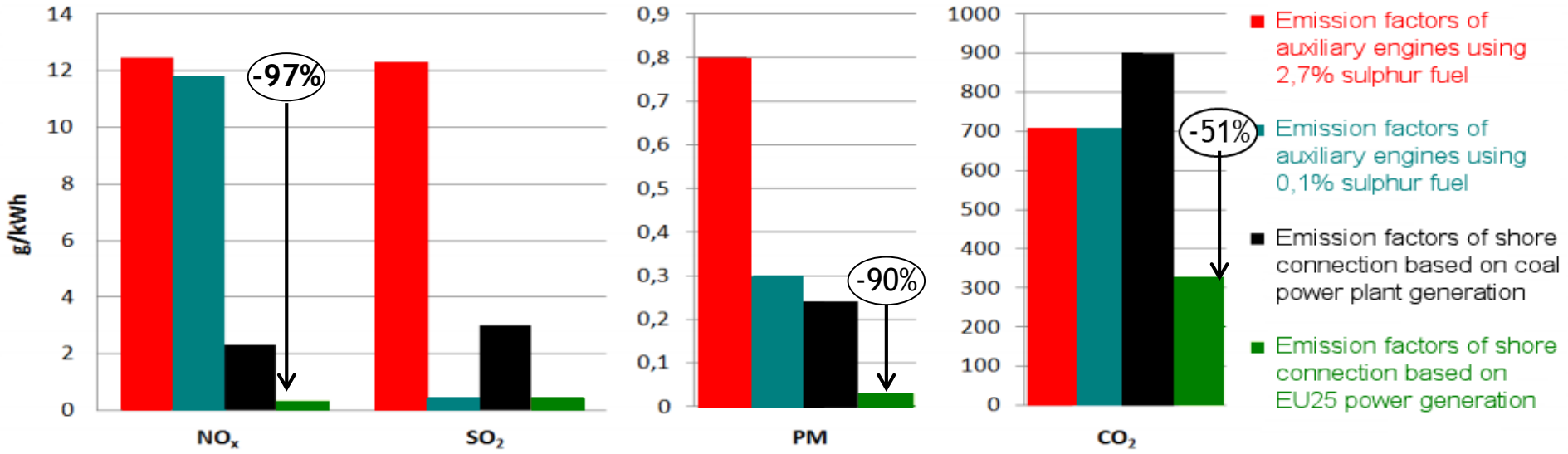
(Diesel Euro VI, 100 km/h)

The power supplied by on-board generators equals the residential power demand of 6.000 people

Environmental benefits of *Cold Ironing*:

- Locally, at the port: zero emission– noise – vibration

- Globally



Source: ENTEC Study 2005

- Today´s best alternative at port

	Emission (g/kWh)		
	EU28 mix	GNL	ULSFO
CO_2	335	430	610
(NO_x, PM, SO_x) eq.	0,43	1,67	22,42

2. *Cold Ironing*

2.1. International regulation

Europe:

- Directive **2005/33/UE** establishes, from 1st January 2010, a maximum Sulphur content of % 0,1 in marine fuels used by ships at berths in EU ports.
- MARPOL Annex VI establishes additional limits regarding emissions of NO_x and SO_2.
- Directive **2014/94/UE** relative to the deployment of an alternative fuels infrastructure, establishes a coverage of *Electricity at shore-side* by end 2025 in ports of TEN-T core network.

Year	IMO MARPOL Annex 6		Directive 2005/33/UE	
	NOx max. (g/kWh)	SO_2 max. (% m/m)		
	Sailing &Port		SECA	Port
2010	11,8	4,5%	1,5%	1,5%
Julio 2010			1,0%	0,1%
2011	9,6			
2012		3,5%		
2015			0,1%	
2016	2,3			
2020		0,5%		

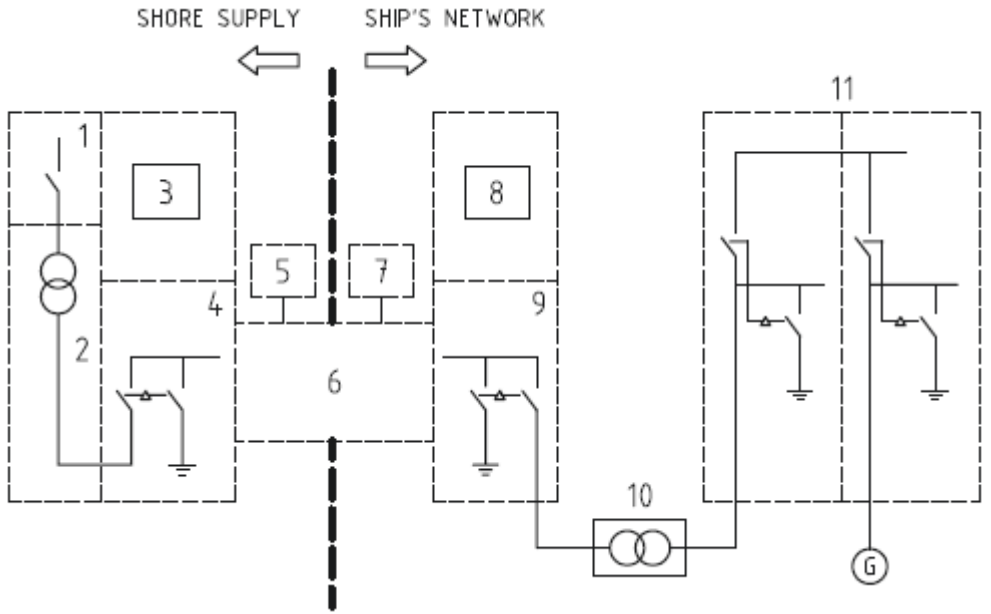
2. *Cold Ironing*

2.2. Technical solution

Standarization:

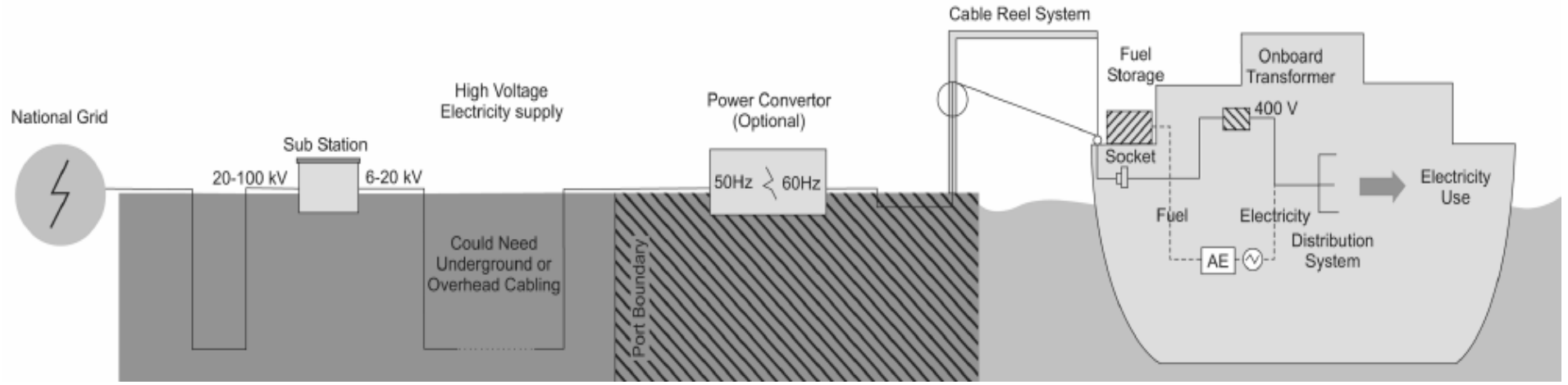
ISO/IEC/IEEE 80005, focuses on “any ship, any port” concept with regard to connecting vessels to shore power.

- **IEC/ISO/IEEE 80005-1 (2012),** High Voltage Shore Connection. 6,6/11 KV and >1 MVA
- **IEC/ISO/IEEE 80005-2**, Communication Protocol
- **IEC/ISO/IEEE 80005-3**, Low Voltage Shore Connection: typical < 1MVA



2.2 Technical solution

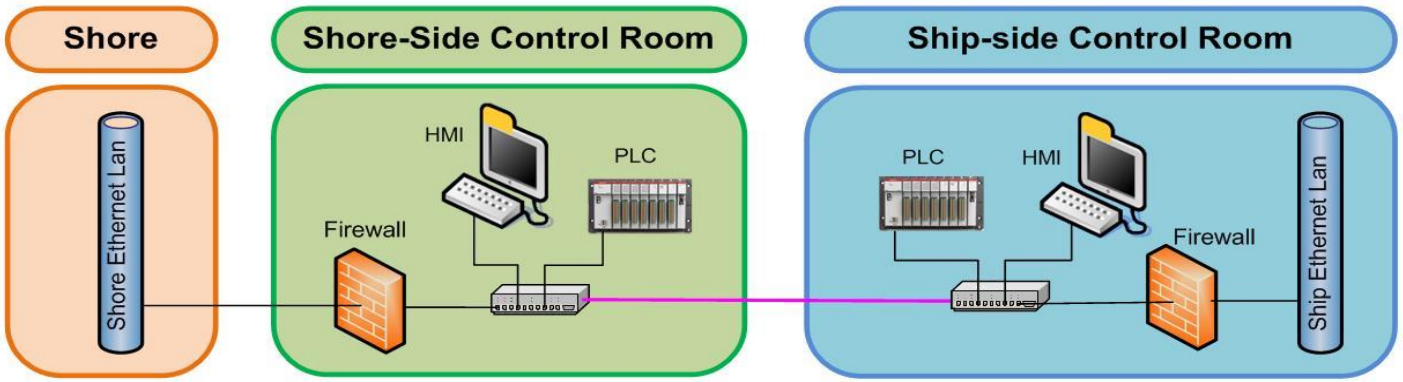
Equipment and solutions:



IEC-61936-1 Electrical installations with nominal voltage >1 kV AC	IEC/ISO/IEEE 80005-1	IEC-60092-nnn Electrical installations in ships

Shore-side installation | **On-board installation**

Case study: Pasaia Port

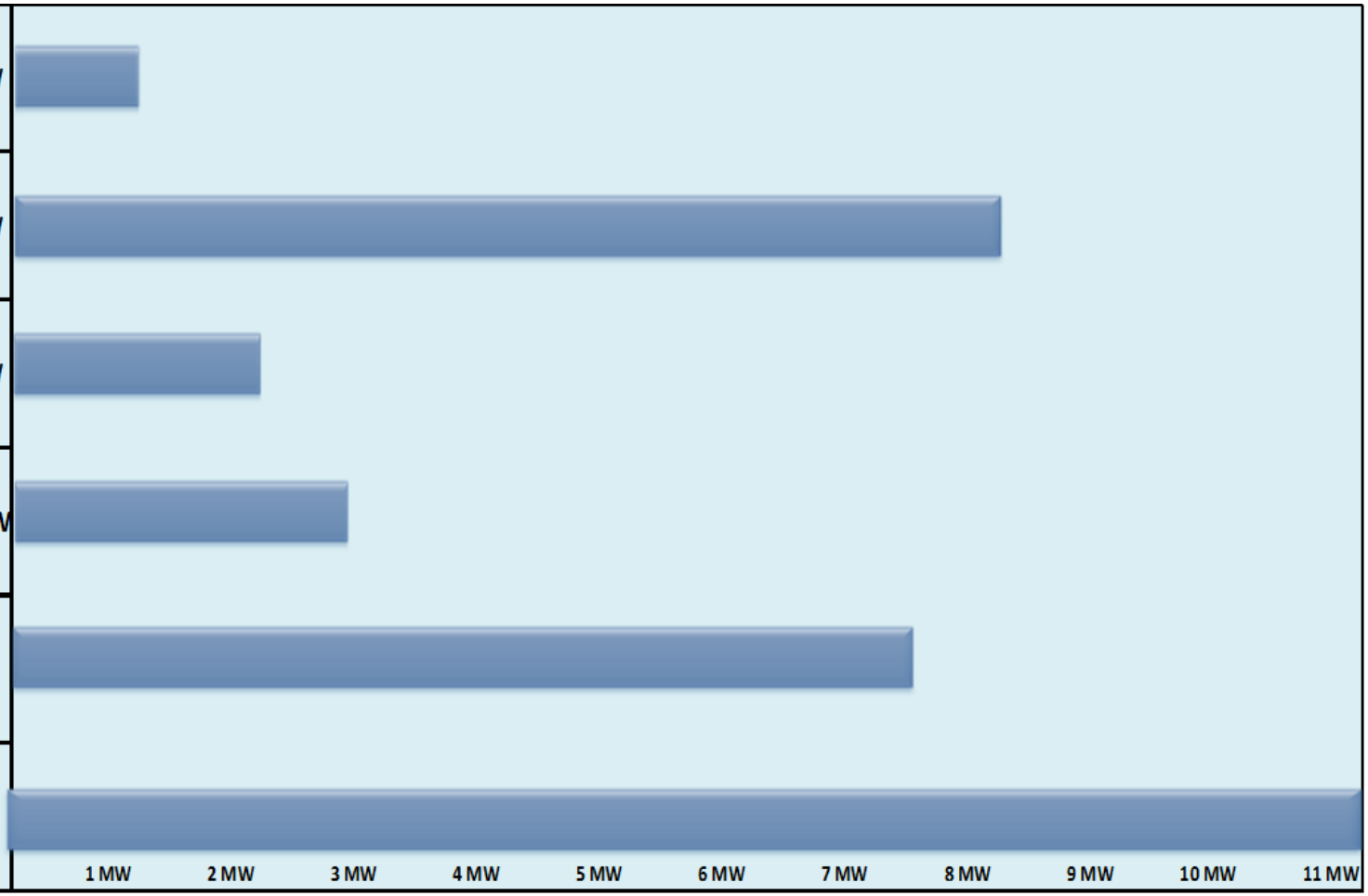


2. *Cold Ironing*

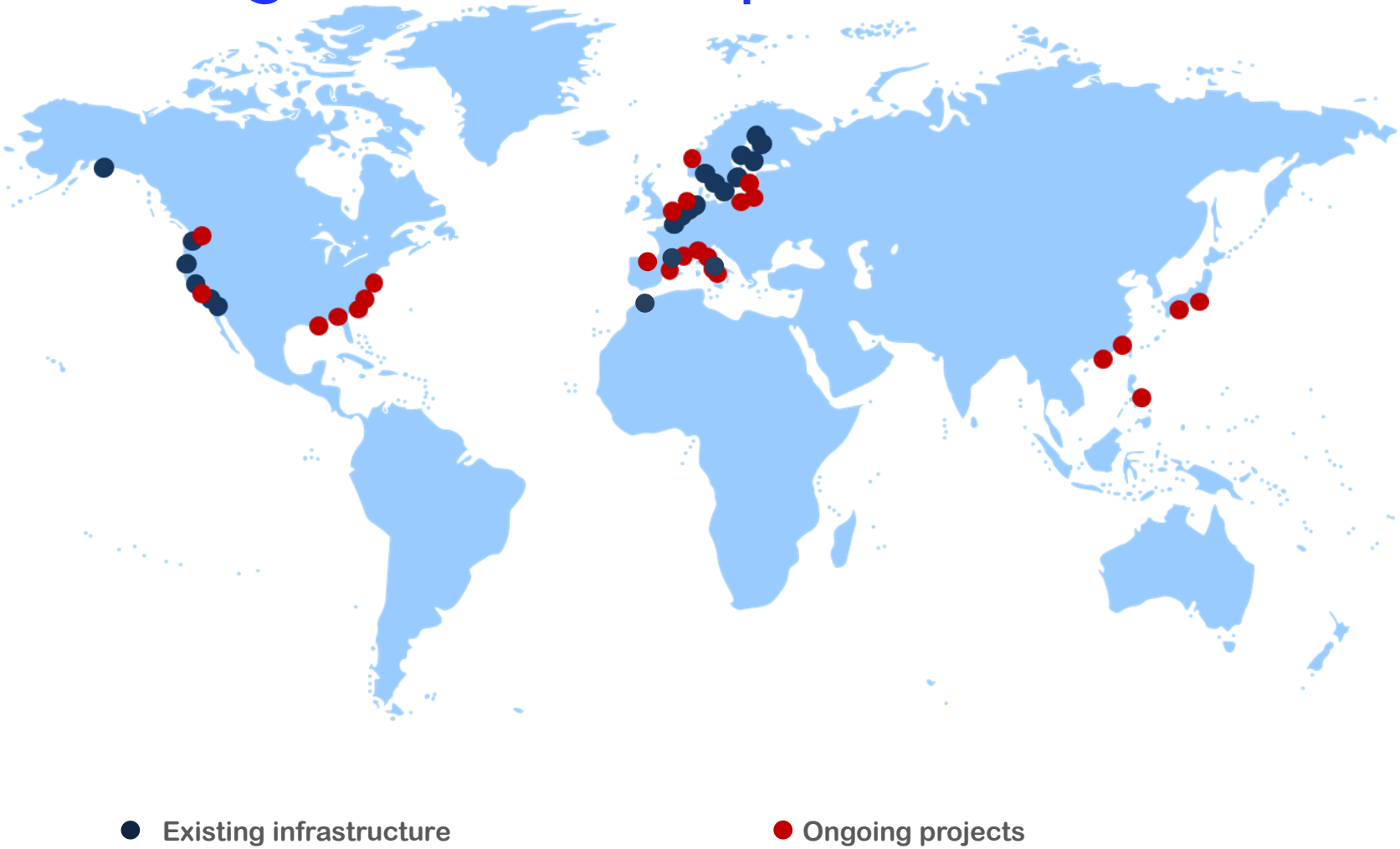
2.3. Facilities on operation and ongoing projects

Power demand requirements of commercial vessels: (MW,kV,Hz)

Container (<140 m)	LV 100% HV / 50 Hz 63% 60 Hz 37%	**0,2-1 MW**
Container (>140 m) **Reefers**	LV 88% HV 12% 50 Hz 6% 60 Hz 94%	**0,8-8 MW**
Ro-Ro **Ro-Pax** **Ferries** **Bulk/cargo**	LV 0% HV 30% 50 Hz 30% 60 Hz 70%	**1,5-2 MW**
Tankers	LV 100% HV 0% 50 Hz 20% 60 Hz 80%	**1,4-2,7 MW**
Cruceros (<200m)	LV 100% HV 0% 50 Hz 36% 60 Hz 64%	**4,1-7,3**
Cruceros (>200m)	LV 12% HV 88% 50 Hz / 60 Hz 100%	**7,5-11**



Cold Ironing worldwide implementation:



Source: World Ports Climate Initiative (WPCI)

2.3 Facilities on operation and ongoing projects

Ports using *Cold Ironing*:

Year of introduction	Port name	Country	Capacity (MW)	Frequency (Hz)	Voltage (kV)	Ship types making use of SSE	Number of berths with SSE installed	Number of unique ships that are connected to SSE at berth	Total number of annual calls that use SSE
2000-2010	Gothenburg	Sweden	1.25-2.5	50 & 60	6.6 & 11	RoRo, ROPAX	6	11	1515
2000	Zeebrugge	Belgium	1.25	50	6.6	RoRo	1	3	200
2001	Juneau	U.S.A	7-9	60	6.6 & 11	cruise	1	3	
2004	Los Angeles	U.S.A	7.5-60	60	6.6	container, cruise	24	54	46
2005-2006	Seattle	U.S.A	12.8	60	6.6 & 11	cruise	2	9	83
2006	Kemi	Finland		50	6.6	ROPAX			
2006	Kotka	Finland		50	6.6	ROPAX			
2006	Oulu	Finland		50	6.6	ROPAX			
2008	Antwerp	Belgium	0.8	50 & 60	6.6	container			
2008	Lübeck	Germany	2.2	50	6	ROPAX			
2009	Vancouver	Canada	16	60	6.6 & 11	cruise	2	10	104
2010	San Diego	U.S.A	16	60	6.6 & 11	cruise	3	4	18
2010	San Francisco	U.S.A	16	60	6.6 & 11	cruise	1	3	38
2010	Verkö, Karlskrona	Sweden	2.5	50		cruise			
2011	Long Beach	U.S.A	16	60	6.6 & 11	cruise	1	1	118
2011	Oslo	Norway	4.5	50	11	cruise	1	1	360
2011	Prince Rupert	Canada	7.5	60	6.6		1		
2012	Rotterdam	Netherlands	2.8	60	11	ROPAX	2	4	
2012	Ystad	Sweden	6.25-10	50 & 60	11	cruise		7	
2013	Trelleborg	Sweden	0-3.2	50	10.5		6		
2015	Hamburg	Germany	12	50 & 60	6.6 & 11	cruise			

Source: World Ports Climate Initiative (WPCI)

Ports planning to use *Cold Ironing*:

- Amsterdam
- Barcelona
- Bergen
- Civitavecchia
- Georgia
- Genoa
- Helsinki
- Hong Kong
- Houston
- Kaohsing
- Los Angeles
- Le Havre
- Livorno
- Marseille
- Nagoya
- Oakland
- Oslo
- Richmond
- Riga
- Rome
- South Carolina
- Stockholm
- Tacoma
- Tallinn
- Tokyo
- Venice
- Yokohama
- Philippines

Source: World Ports Climate Initiative (WPCI)

3. Implementation

3.1. Some relevant figures

Cost analysis: investments, operational costs and cost effectiveness

- **ULSFO** price
- **Electricity** price
- Vessel **power/energy** demand
- **Call duration** at berth
- Number of **calls and frequency**
- **Investments** in port infrastructure and in ship´s equipment
- **Savings** in ship generators **maintenance**
- **Savings in CO_2** allowances
- **Savings** in **port taxes** and other bonus (electricity tariff,..)

3.1 Some relevant figures

- **Investment** in **port** infrastructure: **0,5÷5 M€**, with installed power from 1 MVA to 10 MVA.
- Investment in ship´s equipment: **0,4÷1 M€.**
- Port taxes reduction (**vessel´s tax T-1**): Ro-Pax, 25.000 GT, demanding 1MVA at berth during 2.500 hours/year, could save up to **100.000€/year**, equivalent to 33% of the electricity bill.
- Avoided emissions: (Ro-Pax demanding 1MVA at berth during 2.500 hours/year) **690 ton. of CO_2, 26 ton. of NO_x, 10 ton. of SO_2 and 500 kg of PM.** Equivalent to 9.000 (NOx)/3.000 (PM) cars (20.000 km/year, Average speed 60 km/h, Diesel Euro VI).

4. Summary

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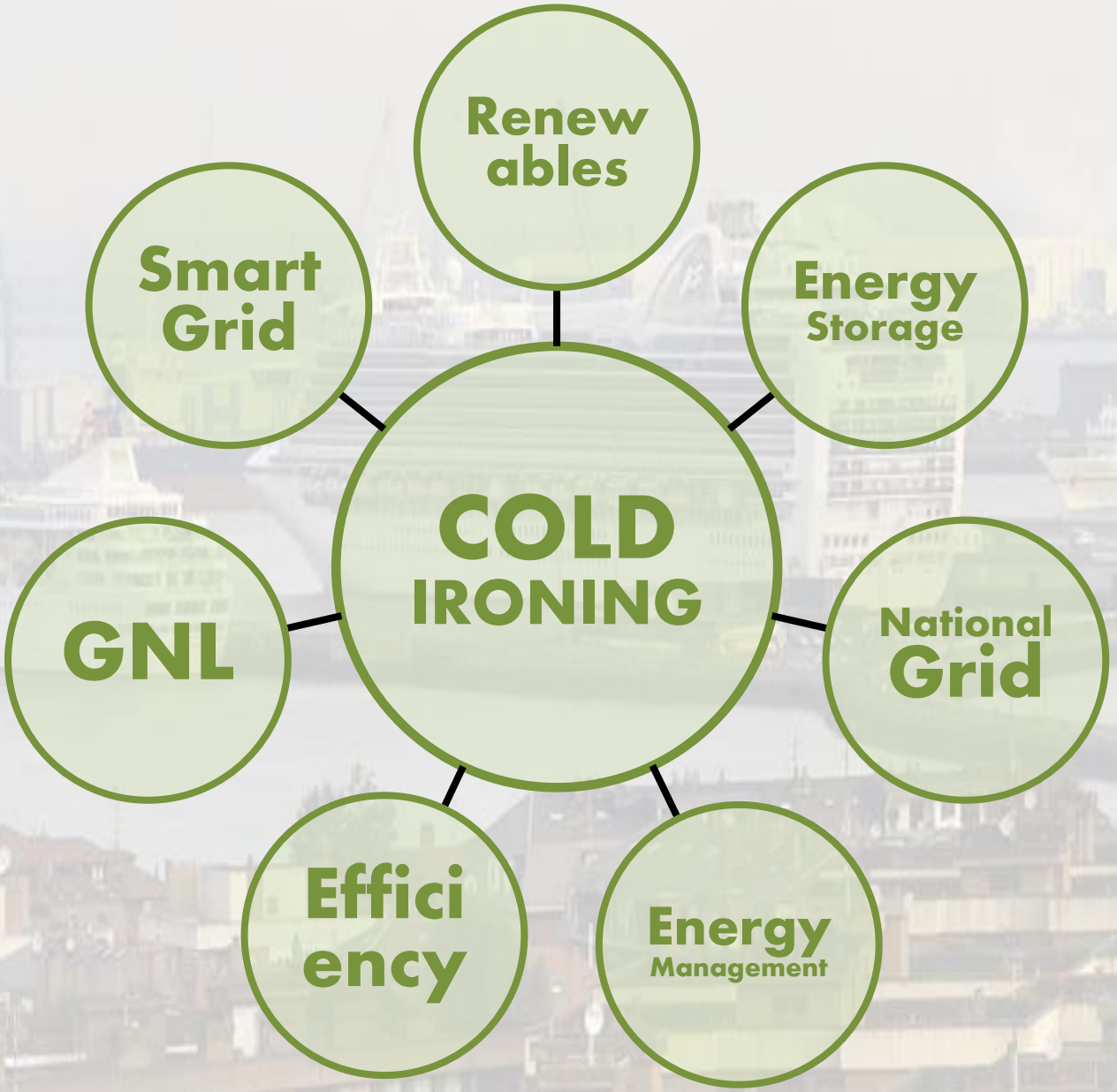
- ***Cold Ironing*** is the unique alternative to cut to ZERO local emissions, noise and vibration.
- ***Cold Ironing*** is a tested technology and successfully implemented at dozens of ports worldwide.
- The ***Cold Ironing*** interoperability is guaranteed following the standardization promoted by ISO/IEC 80005.
- Most of the new vessels are ***Cold Ironing*** ready.
- ***Cold ironing*** is mandatory in the west coast of USA and many other countries are adopting regulations to facilitate the deployment of the required infrastructure, as directive 2014/94/UE.

COLD IRONING

Future Energy ?

COLD IRONING

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