Shore connection solutions

Plug in to green power

Air Pollution from Shipping 15th May 2018

Hugues Berthet

Shore Connection

Business Development

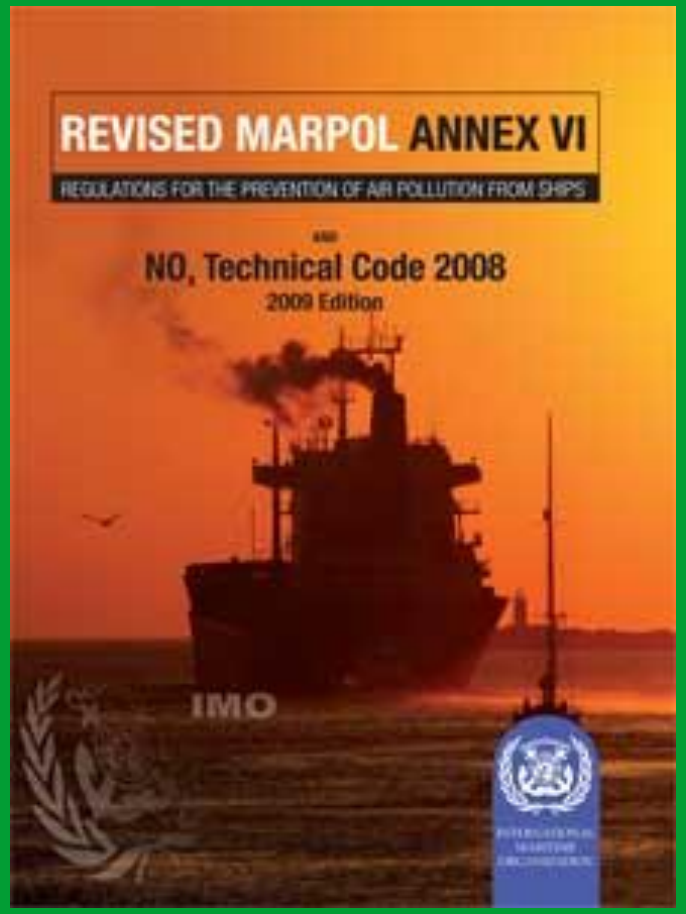
Director

www.schneider-electric.com/shore-connection

Such as airports, there are several years, Ports are currently their revolution to limit pollution and the impact on the environment

International Regulation

IMO, MARPOL Annex 6



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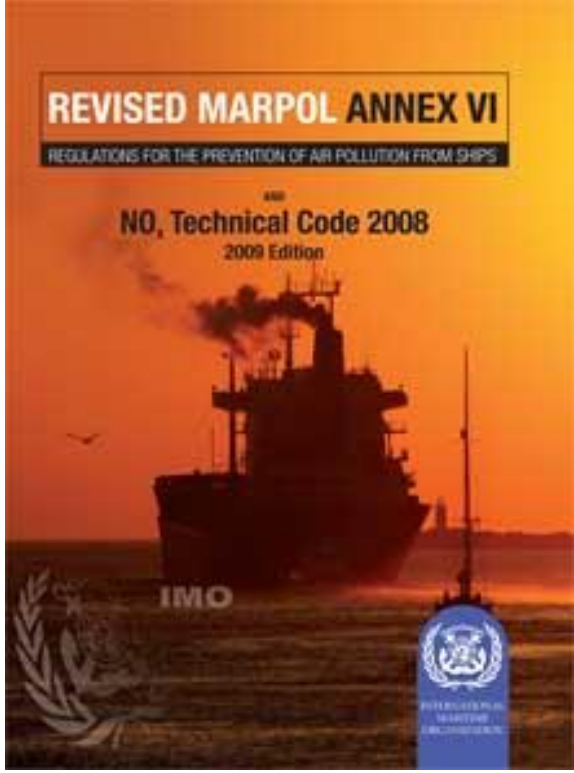
International Regulation MARPOL Annex VI

What is it ?

Regulations to limit air pollution from ships including:

- Limitation of NOx and SOx emissions in fuel oil of all ships



Date	SOx Limit in Fuel (% m/m)			Average Nox Limit in Fuel (g/kWh)
	MARPOL ANNEXE VI		EU maritime fuel sulphur directive (2005/33/EC)	MARPOL ANNEXE VI
	High sea & berth	SECA	Berth	High sea & berth
2009	4,5%	1,5%	1,5%	11,8
2010				
2010, Juny		1,0%	0,1%	
2011				9,6
2012	3,5%			
2015		0,1%		
2016				2,3
2020	0,5%			

IMO and EU encourages implementation of new technologies to cut emission:
SC viewed as one

*SECA = Sulphur Emission Control Area:
Baltic Sea + North sea + English Channel

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EMISSION CONTROL AREAS (ECA)

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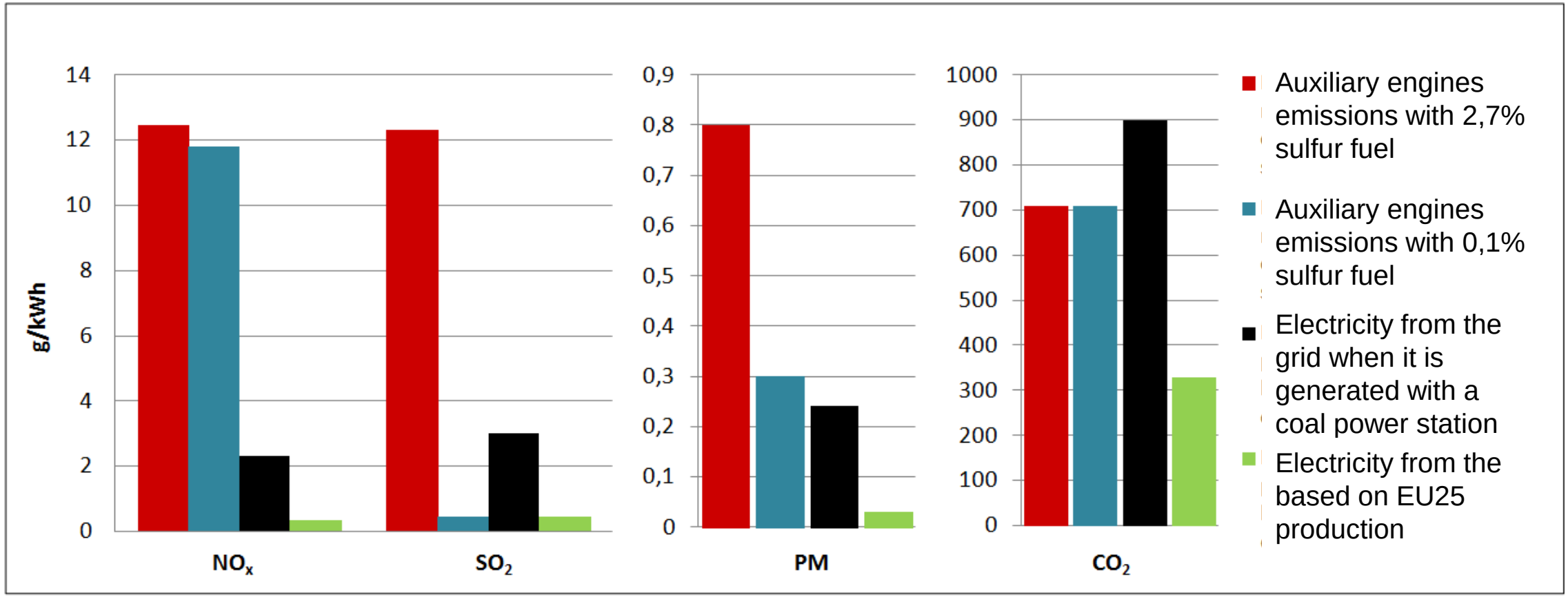
Emission generation levels by Ships in ports compared on energy source

Hypothesis Emissions From Ship Referencial

CO2	645	g/kWh
Nox	13	g/kWh
SO2	0,2	g/kWh
PM	0,3	g/kWh

Land-produced electricity is always less pollutant than burning bunkering fuel



Entec UK Limited, 2005, p.13 et Cousins, 2011,p.31

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Table 1. Summary of Harbor Craft and OGV Emission Factors, Corrected for 15 Parts per Million Sulfur Content in Harbor Craft and 0.1 Percent Sulfur Content in OGVs

Minimum Power (kW)	NO_X (g/kW-hr)	VOC (g/kW-hr)	CO (g/kW-hr)	PM_{10} (g/kW-hr)	SO_2 (g/kW-hr)	CO_2 (g/kW-hr)	CH_4 (g/kW-hr)	N_2O (g/kW-hr)
Harbor Craft [a/]								
Category 1 – Tier 1 Engines								
37 - 75	9.8	0.27	2	0.77	0.007	690	0.02	0.09
75 - 130	9.8	0.27	1.7	0.34	0.007	690	0.02	0.09
130 - 225	9.8	0.27	1.5	0.34	0.007	690	0.02	0.09
225 - 450	9.8	0.27	1.5	0.26	0.007	690	0.02	0.09
450 - 560	9.8	0.27	1.5	0.26	0.007	690	0.02	0.09
560 - 1000	9.8	0.27	1.5	0.26	0.007	690	0.02	0.09
1,000 +	9.8	0.27	5	0.26	0.007	690	0.02	0.09
Category 2 – Tier 2 Engines								
	9.8	0.5	5	0.62	0.001	690	0.02	0.09
Ocean-going Vessels								
Category 3 [b/] Main Engines	13.20	0.5	1.10	0.19	0.397	646.08	0.004	0.031
All Categories Aux. Engines	13.9	0.40	1.10	0.18	0.42	690.71	0.004	0.031

Notes:

a/ Category 1 engines have a displacement less than 5 liters per cylinder (L/cyl), Category 2 engines have a displacement greater than or equal to 5 (L/cyl) and less than 30 L/cyl, and Category 3 engines have a displacement greater than or equal to 30 L/cyl.

b/ The emission factors for the Category 3 engines were based on a medium-speed diesel vessel using marine diesel oil fuel.

Source

AIR EMISSION CALCULATIONS AND METHODOLOGY

Virginia Offshore Wind Technology Advancement Project

(VOWTAP)

Prepared for:

Dominion

5000 Dominion Boulevard
Glen Allen, VA 23060

Prepared by:

TETRA TECH

Tetra Tech, Inc.
4101 Cox Road, Suite 120
Glen Allen, VA 23060

www.tetratech.com

Submitted December 2013

Revised October 2014

Efficiency of Electricity production Shore Connection an attractive solution

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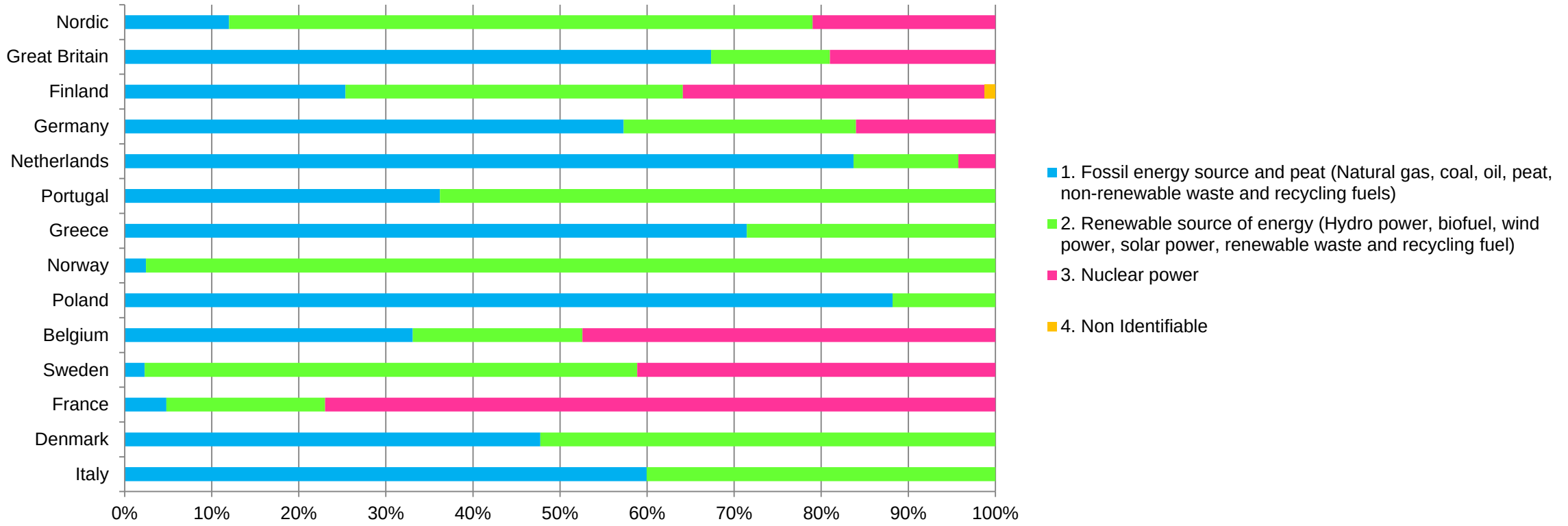
Energy Mix per country

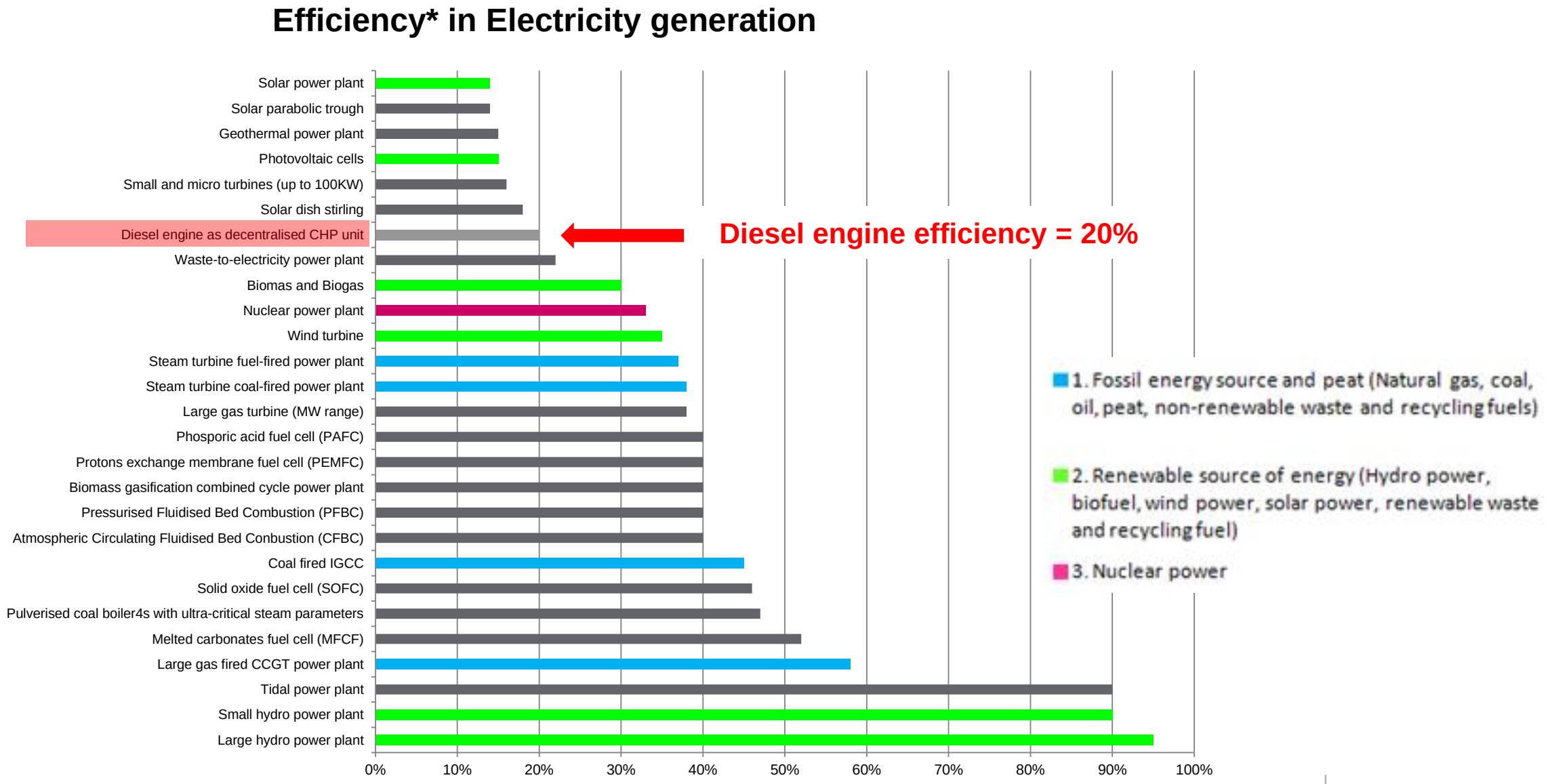


Energy Mix 2014	Italy	Nordic	Denmark	France	Sweden	Belgium	Poland	Norway	Greece	Portugal	Netherlands	Germany	Finland	Great Britain
1. Fossil energy source and peat (Natural gas, coal, oil, peat, non-renewable waste and recycling fuels)	60%	12%	48%	5%	2%	33%	88%	2%	71%	36%	84%	57%	25%	67%
2. Renewable source of energy (Hydro power, biofuel, wind power, solar power, renewable waste and recycling fuel)	40%	67%	52%	18%	57%	20%	12%	98%	29%	64%	12%	27%	39%	14%
3. Nuclear power	0%	21%	0%	77%	41%	47%	0%	0%	0%	0%	4%	16%	35%	19%
4. Non Identifiable	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%

Ref : entsoe (european network of transmission system operators for electricity) 2014

Nordic = Denmark, Finland, Norway, Sweden, Estonia

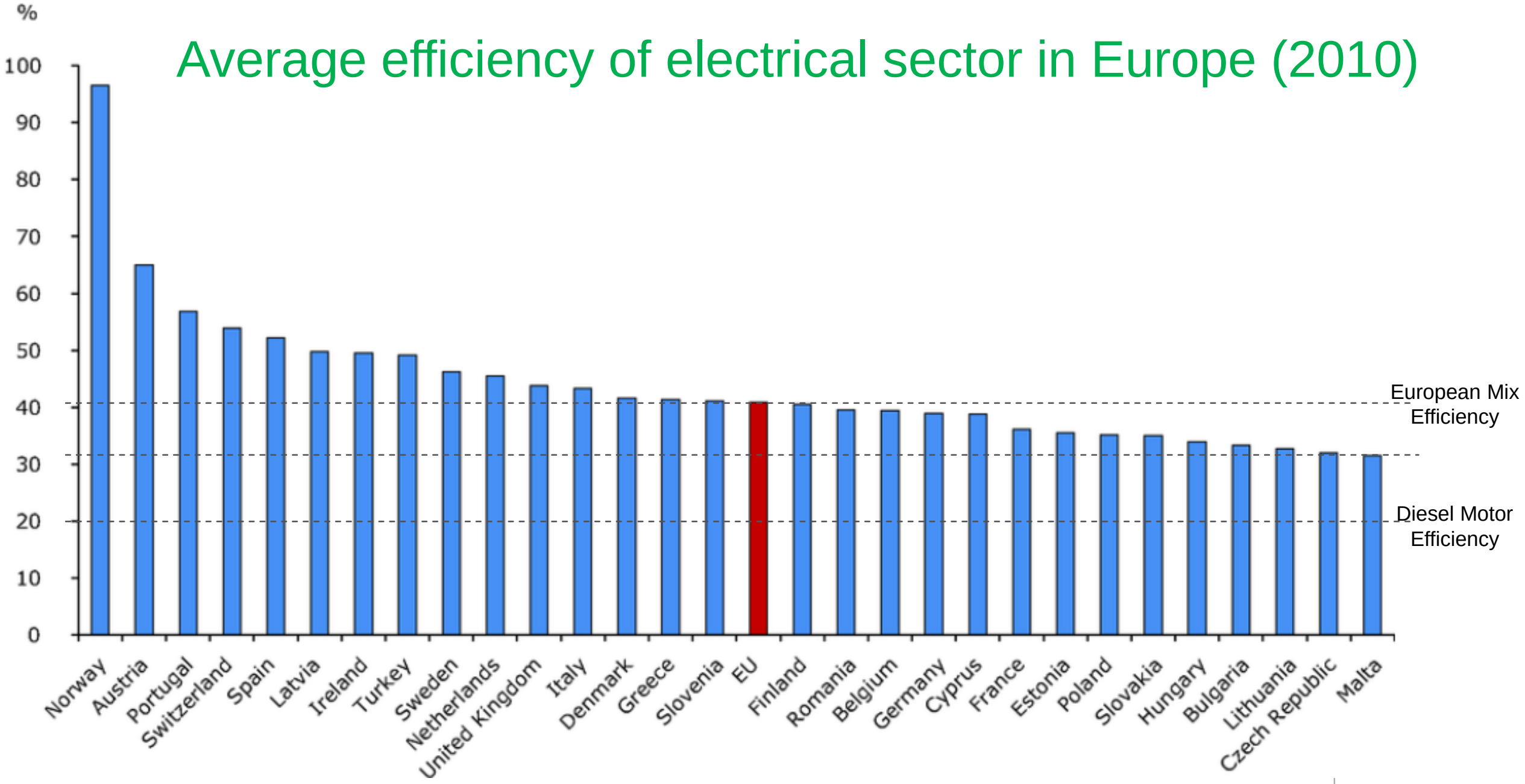
How is the Efficiency in various generation technology ?



Source : EURELECTRIC "Presentation of Resources"

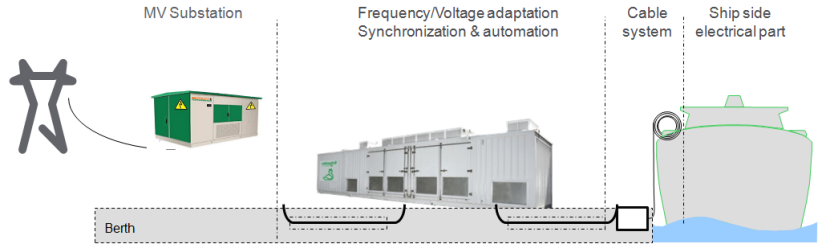
(*) Electric power plant **efficiency** = $\frac{\text{electricity output from generating unit}}{\text{energy value of the energy source}}$

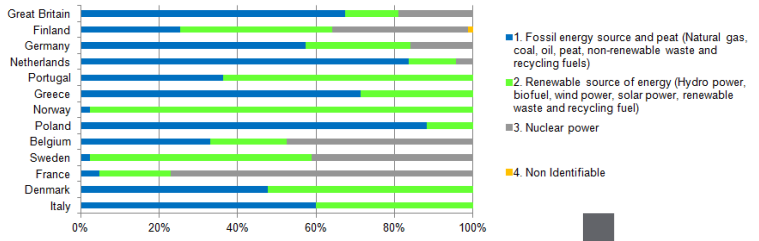
Average efficiency of electrical sector in Europe (2010)

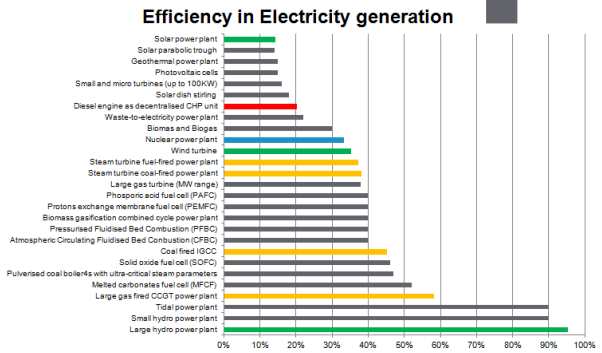


http://www.eea.europa.eu/data-and-maps/indicators/overview-of-the-electricity-production/assessment/#tlspu_cookiepolicy_title

What is the efficiency Energy Mix when ship is plugged to grid ?







%	Energy Mix Efficiency
Belgium	38%
Denmark	32%
Finland	45%
France	40%
Germany	36%
Greece	46%
Italy	56%
Netherlands	35%
Norway	89%
Poland	45%
Portugal	48%
Sweden	55%
Great Britain	43%
Nordic	68%

Loss
5% Electricity transportation
10% Frequency conversion

%	Electricity Efficiency delivered to ship
Belgium	32%
Denmark	27%
Finland	38%
France	34%
Germany	31%
Greece	39%
Italy	48%
Netherlands	30%
Norway	76%
Poland	38%
Portugal	41%
Sweden	47%
Great Britain	37%
Nordic	58%

Nordic = Denmark, Finland, Norway, Sweden, Estonia

Efficiency of Electricity generate by Ship Auxiliary Engine at port compare to connection to the Grid

Electricity Grid generation

%	Electricity Efficiency delivered to ship
Denmark	27%
Italy	48%
Norway	76%

Electricity Ship generation

%	Electricity Efficiency generated by Ship
Diesel Engine	20%

Comment :

Even if the Efficiency of the Energy Mix in Denmark is the lowest,
The Auxiliary Engine on board is less Efficient !

CO2, CO2, NOx, PM emission Shore Connection better for the planet

CO2 emission of Energy Mix production compare to Ship

Electricity production emission (g/kWh)

(g/kWh)	CO2 Emission
Belgium	253,61
Denmark	328,84
Finland	177,79
France	92,40
Germany	503,42
Greece	904,18
Italy	404,65
Netherlands	432,86
Norway	4,54
Poland	810,42
Portugal	505,74
Sweden	43,60
Great Britain	496,28

Source : eea.europa.eu 2015

SHIP emission (g/kWh)

CO2 emission	(g/kWh)
Emission from Auxiliary engines using 0,1% sulphur marine gas oil (MGO)*	645

** Source : Feasibility Study of Cold-ironing Technology in Copenhagen FABIO BALLINI - UNIVERSITY OF GENOA, Italy 2013*

CO2 emission from the 70 cruise vessels with a total of 308 calls *visiting the Port of Copenhagen in the summer season of 2012 (May-October) ~ energy demand 31674 MWh*

Comment:

In France, plug a ship to electricity reduce CO2 emission by 86%

NOx, SO2, PM emission compare to Ship

Nordic countries case

Production / emissions	NOx (g/kWh)	SO2 (g/kWh)	PM (g/kWh)
Emission from Auxiliary engines using 0,1% sulphur marine gas oil (MGO)*	13,2	0,2	0,3
Nordic Energy Mix	0,32	0,07	0,03
Reduction emission	**98%**	**65%**	**90%**

** Source : Feasibility Study of Cold-ironing Technology in Copenhagen*
FABIO BALLINI - UNIVERSITY OF GENOA, Italy 2013
NORDIC = Denmark, Norway, Sweden, Finland and Estonia.
For an Energy demand 31674 MWh/season

Comment:

In Nordic, plug a ship to electricity strongly reduce NOx, SO2 and PM emission

CO_2, NO_x, SO_2, PM annual emissions from Ship and financial impacts

Hypothesis	Emissions From Ship Referencial		
	CO2	645	g/kWh
	Nox	13	g/kWh
	SO2	0,2	g/kWh
	PM	0,3	g/kWh

One Ferry Ship
12h/day/365days
Power : 3MVA

Result	Ship Emissions simulation				At berth		
					Power	3	MVA
	CO2	8475,3	Ton		Time at berth	4380	Hours
	Nox	170,82	Ton				
	SO2	2,628	Ton		HLSMGO	500 €	
	PM	3,942	Ton		Electricity	0,08 €	
	LSMGO (200g/kWh)	2628	Ton	→	Fioul Price	1 314 000 €	
	LSMGO (250g/kWh)	3285	Ton	→	Fioul Price	1 642 500 €	
	LSMGO (300g/kWh)	3942	Ton	→	Fioul Price	1 971 000 €	
	Energy Consumed	13140	MWh	→	Electricity Price	1 051 200 €	

Our references

Plug Into
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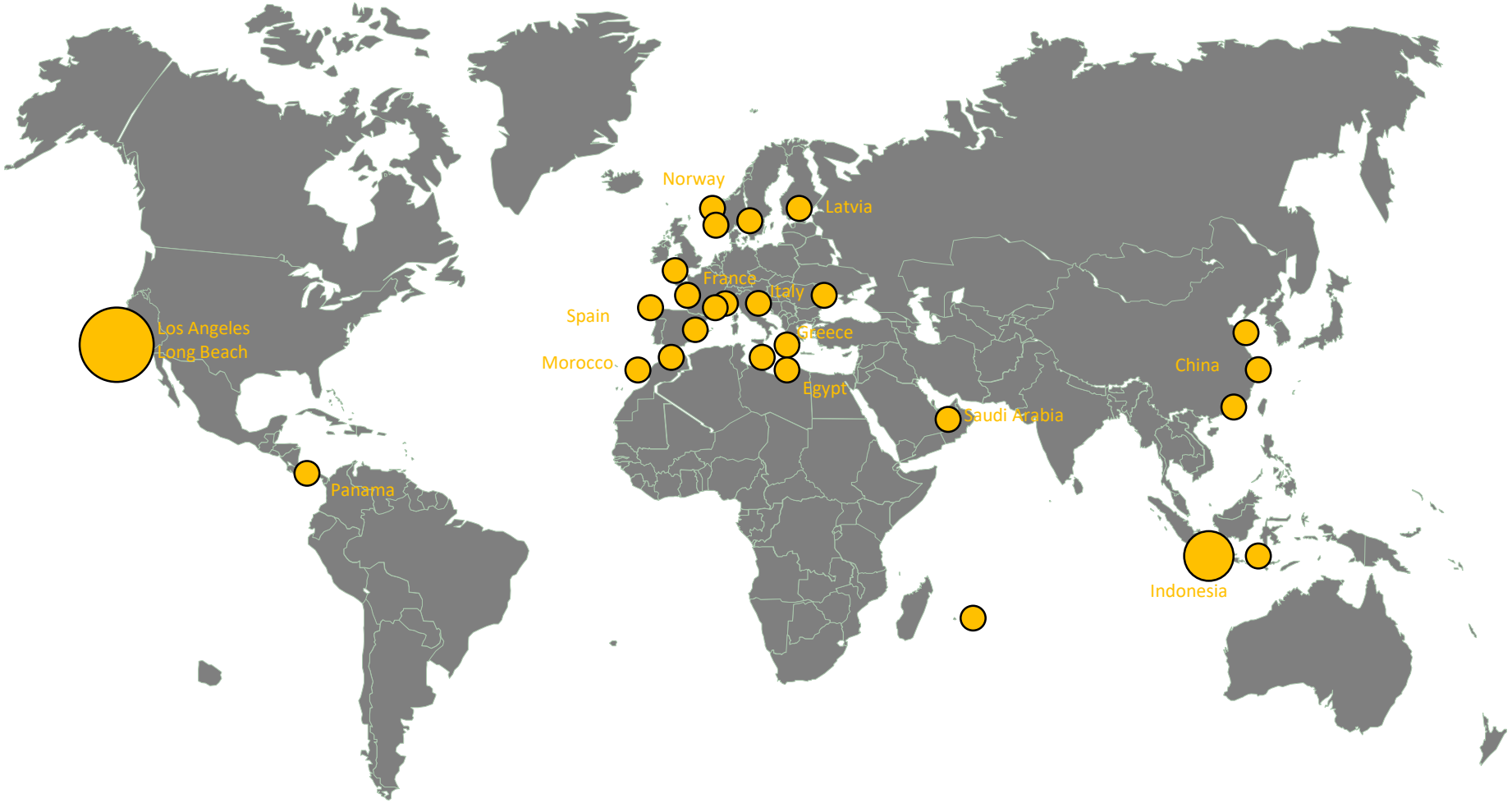
Schneider Electric worldwide references



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ShipYard at Port of Ancona in Italy, ShoreBoX 2MVA

Ship Emissions per day		
CO2	30,96	Ton
Nox	0,624	Ton
SO2	0,0096	Ton
PM	0,0144	Ton

Schneider Electric Italy has successfully installed and commissioned a 2-MVA ShoreBoX™ to power the Viking Sea cruise ship during its construction period in Fincantieri Ancona shipyard.

July 2015

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OSV connection at Port of Bergen

Result	Ship Emissions per day		
	CO2	11,61	Ton
	Nox	0,234	Ton
	SO2	0,0036	Ton
	PM	0,0054	Ton

Ship Emissions per day		
CO2	15,48	Ton
Nox	0,312	Ton
SO2	0,0048	Ton
PM	0,0072	Ton

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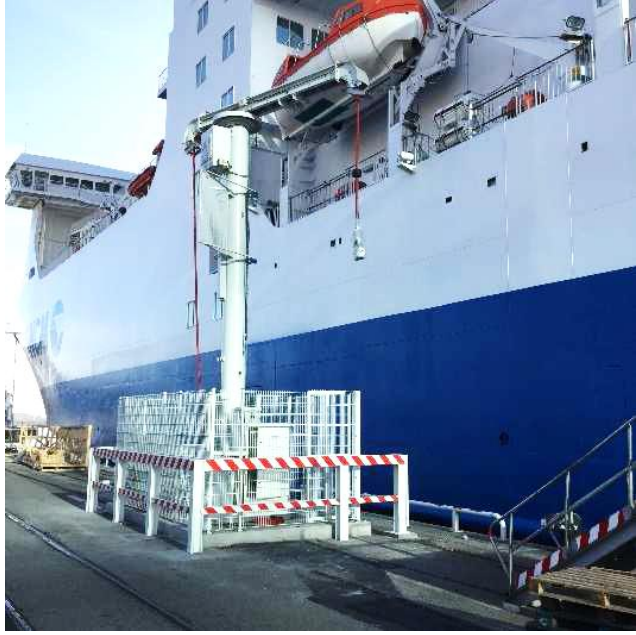

Ship Emissions per day		
CO2	13,932	Ton
Nox	0,2808	Ton
SO2	0,00432	Ton
PM	0,00648	Ton

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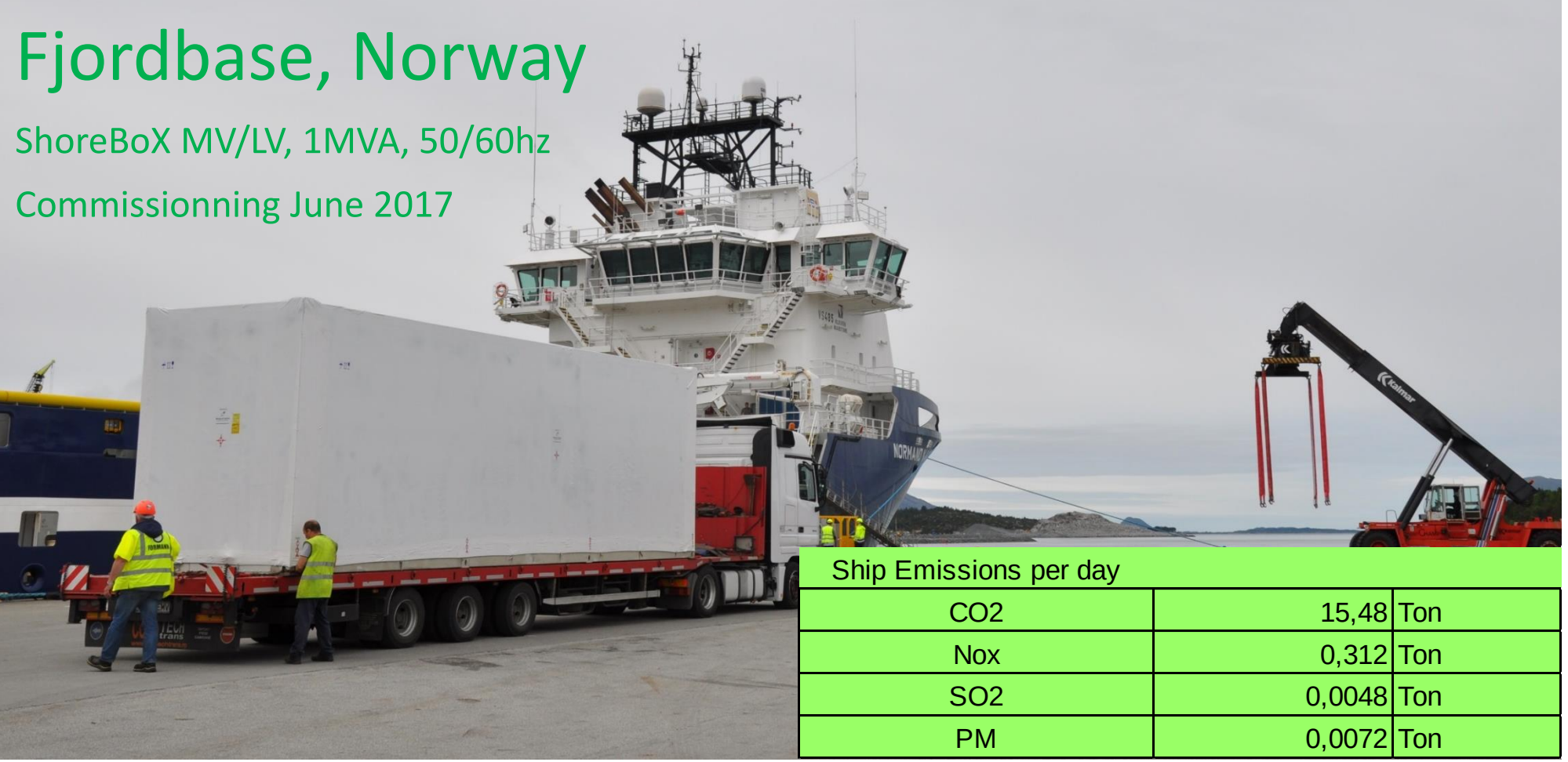
Biggest Yacht of the World
Dilbar, 156m, Antibes France
November 2016

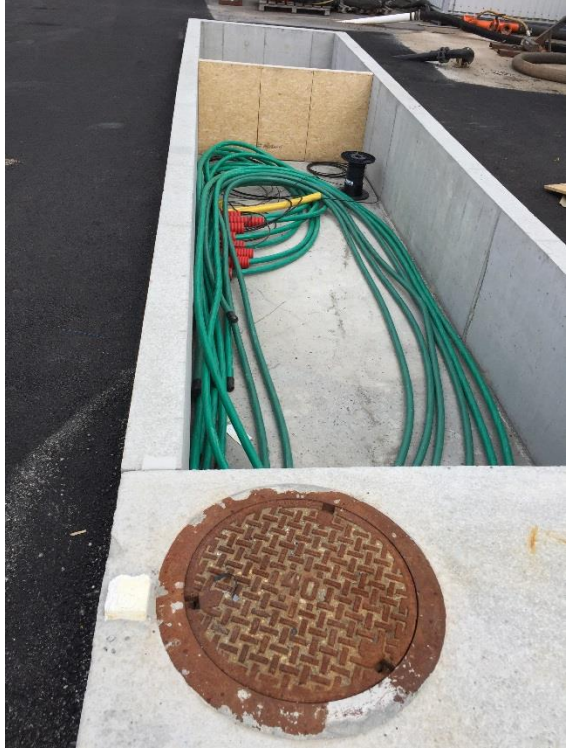
Ship Emissions per day		
CO2	43,344	Ton
Nox	0,8736	Ton
SO2	0,01344	Ton
PM	0,02016	Ton

Fjordbase, Norway

ShoreBoX MV/LV, 1MVA, 50/60hz

Commissionning June 2017





Ship Emissions per day		
CO2	15,48	Ton
Nox	0,312	Ton
SO2	0,0048	Ton
PM	0,0072	Ton

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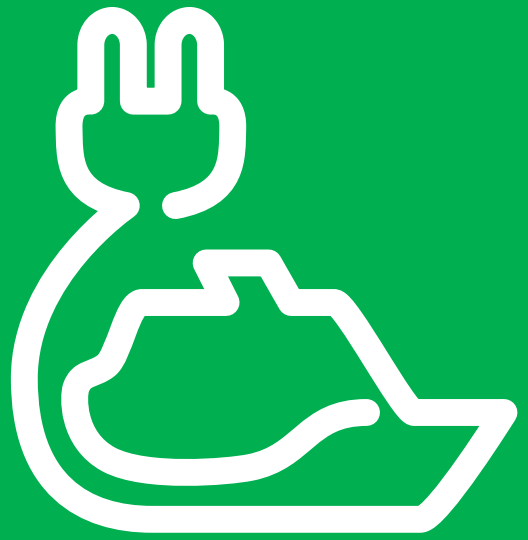
Green Power

Shore Connection Solution



Thank you for your attention

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