Beneficios de las ECA
La experiencia internacional

Dimarts, 15 de gener de 2019

Museo Marítimo, Barcelona

Plataforma per la **Qualitat de l'Aire**

Emisiones contaminantes

CO_2	NO_x	SO_x	PM	COV	CO	Sustancias agotan capa ozono

CLASIFICACIÓN

Las **emisiones a la atmósfera** de los buques pueden clasificarse en **contaminantes atmosféricos, gases de efecto invernadero y sustancias que agotan la capa de ozono**.

FUENTES

1. **Motores de combustión interna DIESEL.**
2. **Sistemas de incineración de residuos.**
3. **Emisiones fugitivas de equipos frigoríficos.**
4. **Emisiones de sistemas de carga de buques tanque.**

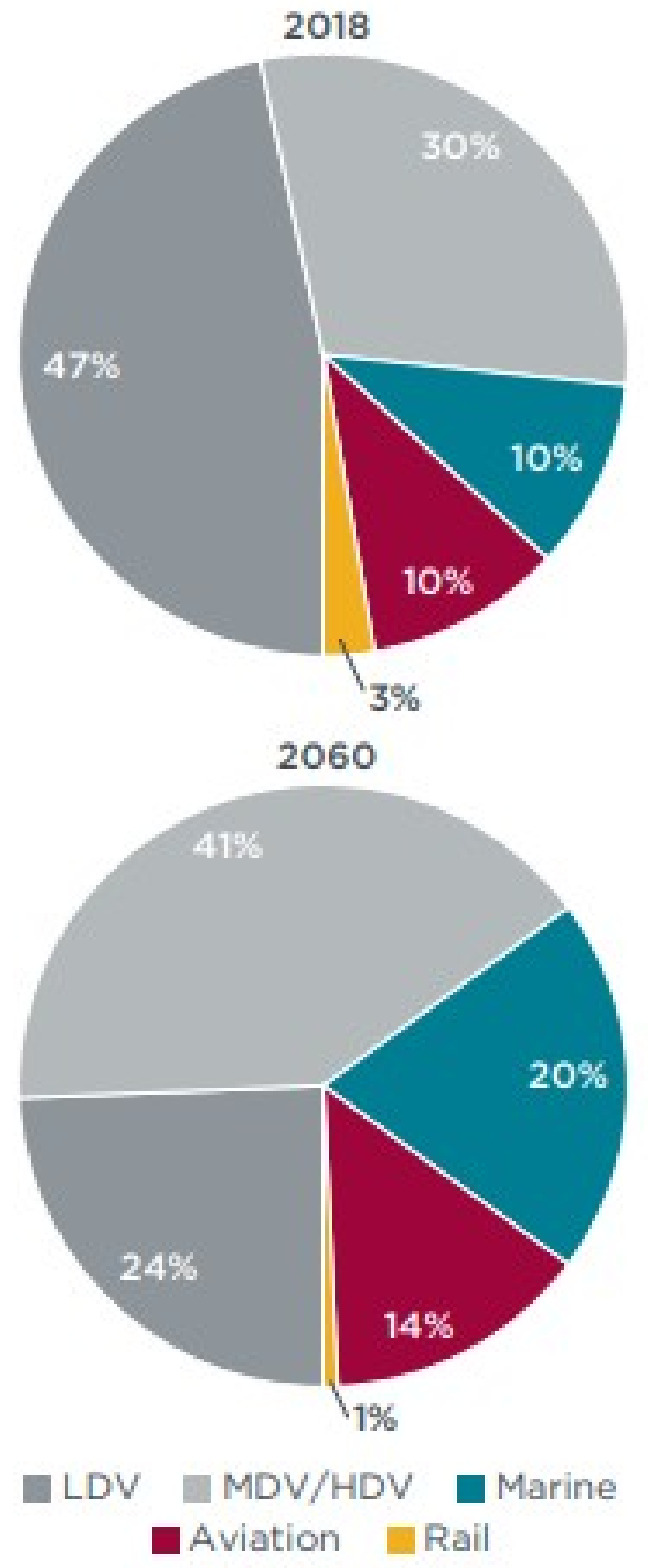


Figure 1. Share of global transport-related greenhouse gas emissions by mode in 2018, and projections for 2060.

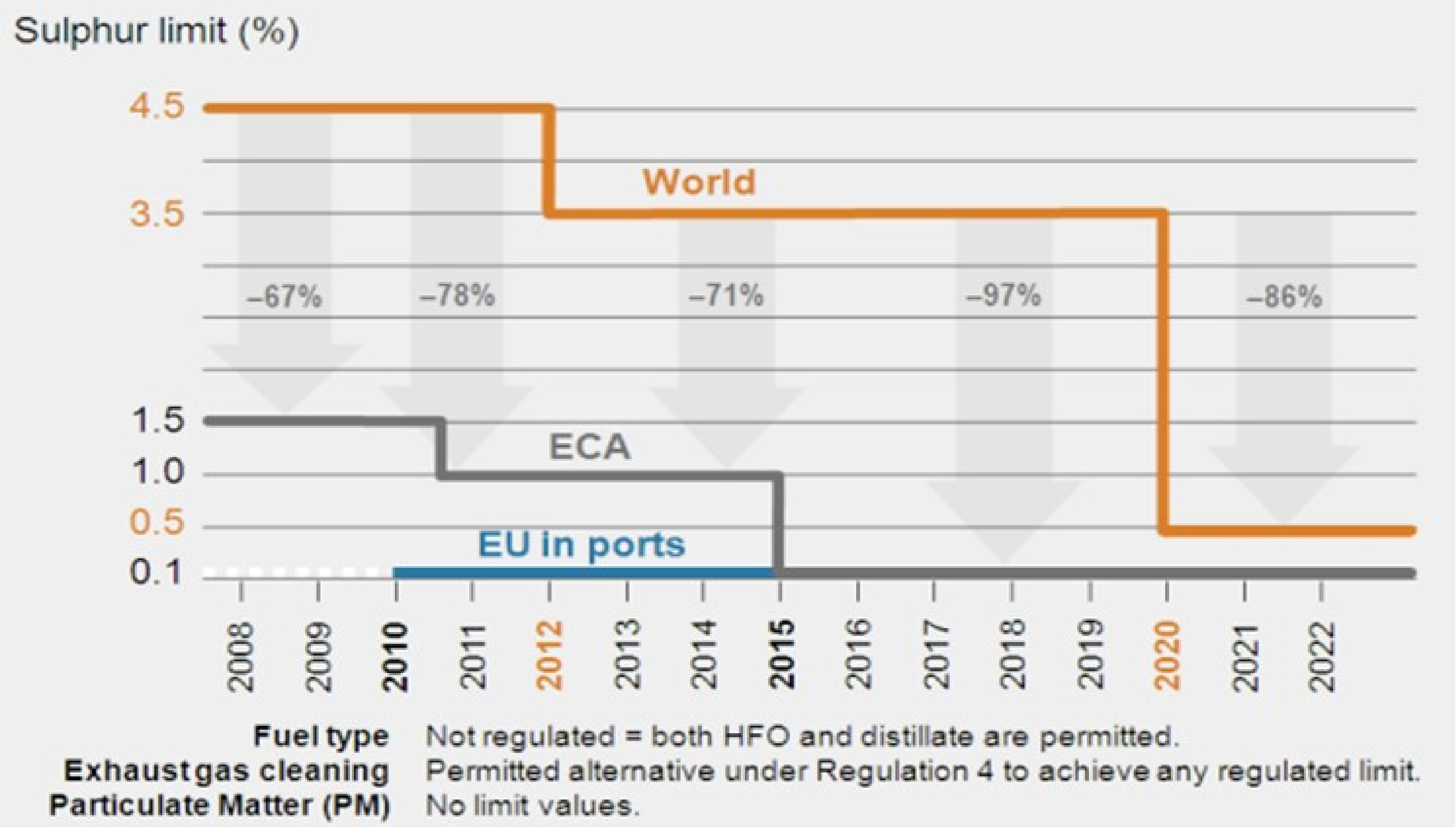
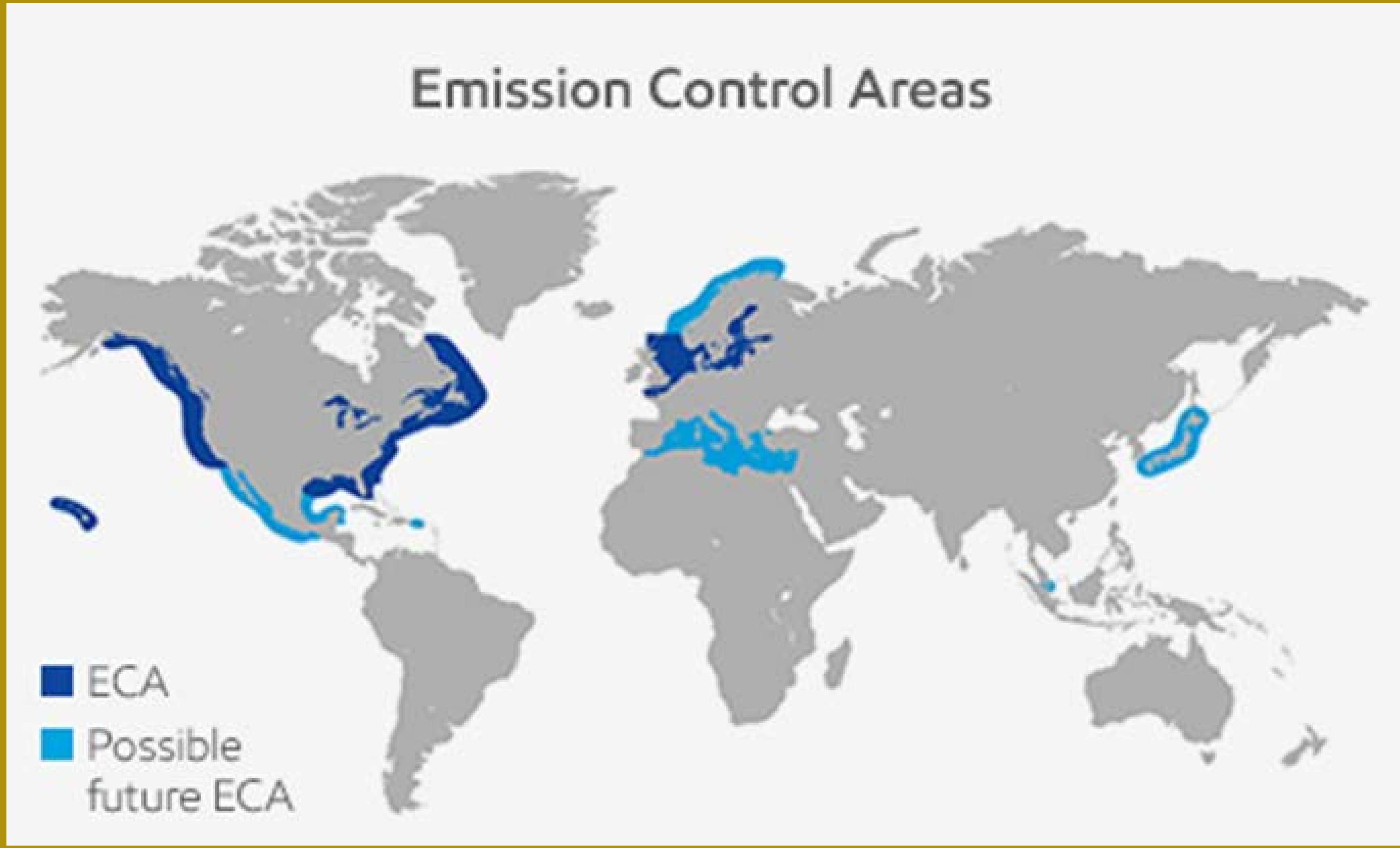


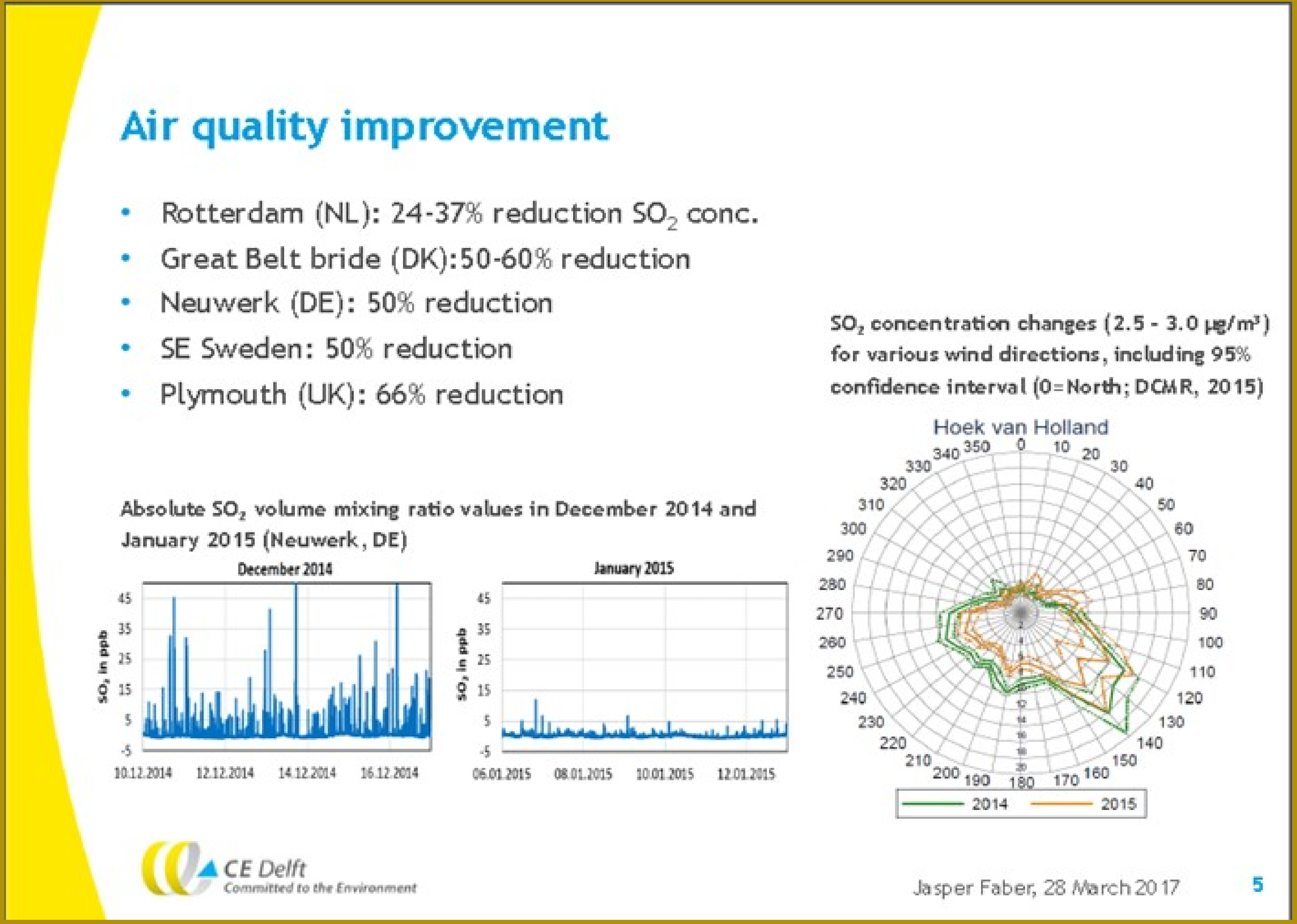
Figure 2. IMO sulphur limits for years 2008-2020 (% mass).



Resultados ECA Norte

- Redución de emisiones.
- Incorporación de mejoras tecnológicas (barcos y puertos).
- Mejora control cumplimiento directivas.

Reducción emisiones



Tecnologías cero emisiones

Table 3. Summary of zero-emission maritime projects.

Technology	Vessel or project	Capacity	Route length (km)	Region	Entry into service	Status
Hydrogen fuel cell ferry	FCS *Alsterwasser*	100 passengers	—	Hamburg, Germany	2009	Decommissioned in 2013
Hydrogen fuel cell tour boat	*Nemo H2*	87 passengers	Up to 150	Amsterdam, Netherlands	2009	Unknown
Plug-in hybrid ferry	Caledonian Maritime Assets	150 passengers, 25 vehicles	~6	Scotland	2011	Operational
Electric ferry (supercapacitor)	*Ar Vag Tredan*	113 passengers	4.5	Lorient, France	2013	Operational
Electric cable ferry	Quyon Ferry	90 passengers, 21 vehicles	0.8	Ottawa, Canada	2013	Operational
Plug-in hybrid fishing boat	*Karoline*	—	—	Norway	2015	Operational
Battery-electric ferry	*Ampere*	360 passengers, 120 vehicles	5.6	Norway	2015	Operational
Plug-in hybrid tourist ship	*Vision of the Fjords*	400 passengers	36	Norway	2016	Operational
Battery-electric ferry	*Elektra*	90 vehicles	1.6	Finland	2016	Operational
Battery-electric ferry	MF *Gloppefjord* and MF *Eidsfjord*	110 vehicles	2	Norway	2017	Operational
Battery-electric ferry	HH Ferries Group	1,250 passengers, 500 vehicles, 9 train cars	4	Sweden	2017	Operational
Battery-electric service boat for aquaculture	*Elfrida*	—	—	Norway	2017	Operational
Battery-electric ferry (solar)	*Aditya*	75 passengers	2.5	Kerala, India	2017	Operational
Battery-electric cargo ship	Guangzhou Shipyard	2,000 tonnes	80	Guangzhou, China	2017	Operational
Hydrogen ferry (combustion)	*Hydroville*	16 passengers	~6.5	Antwerp, Belgium	2017	Operational
Battery-electric tourist ship	*Future of the Fjords*	400 passengers	36	Norway	2018	In development
Plug-in passenger ship	Hurtigruten	530 passengers	—	Norway	2018	In development
Plug-in offshore construction vessel	*North Sea Giant*	120 passengers, 400-ton crane	—	Norway	2018	Operational
Plug-in hybrid ferry	Color Line	Up to 2,000 passengers and 500 vehicles	67	Norway and Sweden	2019	In development
Battery-electric cargo ship	*Yara Birkeland*	2,880 tons	56	Norway	2019	Under construction
Plug-in sailing ship	*Statsraad Lehmkuhl*	190 passengers		Norway	2019	In retrofit
Hybrid hydrogen electric ferry	Fiskerstrand PILOT-E	80 vehicles	~4	Norway	2020	In development
Hydrogen fuel cell cruise ship	Viking Cruises	1,400 passengers and crew	—	Norway	N/A	In development

Table 6. Qualitative scoring rubric for technology assessments applied below.

Score	Technological readiness and feasibility	Cost	Greenhouse gas emission reduction potential
5	Currently in widespread use	Least expensive option available	Lifecycle zero-emission using widely available fuel pathways
4	Appears poised for commercial introduction	Cost-competitive with conventional alternative	>50% emissions reduction from fossil fuel baseline
3	Early demonstration, but not yet ready for commercial deployment	Lower upfront or fuel cost, but uncertain or somewhat negative total cost of ownership	1 to 50% emissions reduction from fossil fuel baseline
2	Not yet built, but appears possible with near-term technology	Would require substantial financial support in the short to medium term	Approximately even with fossil fuel baseline using widely available fuel pathways
1	Faces extreme difficulties using near-term technology, or not logistically feasible to implement	Prohibitively expensive	Higher emissions than fossil fuel baseline under most circumstances

Table 8. Qualitative assessment of readiness, costs, and emission reduction potential for battery-electric, hydrogen fuel cell, and ammonia fuel cell maritime vessels.

	Battery electric			Hydrogen			Ammonia		
	Readiness/ feasibility	Cost	Emissions	Readiness/ feasibility	Cost	Emissions	Readiness/ feasibility	Cost	Emissions
Ferries and harborcraft	4	4	5	3	2	3	2	2	2
Inland and short-sea shipping	3	3	4	3	2	3	2	2	2
Transoceanic container ships	1	1	4	2	2	3	2	3	2

Fuente. Survey of zero-emission technology options across the transport sector. July 18, 2018. International Council on Clean Transportation ICCT

Emisiones GEI según tecnologías

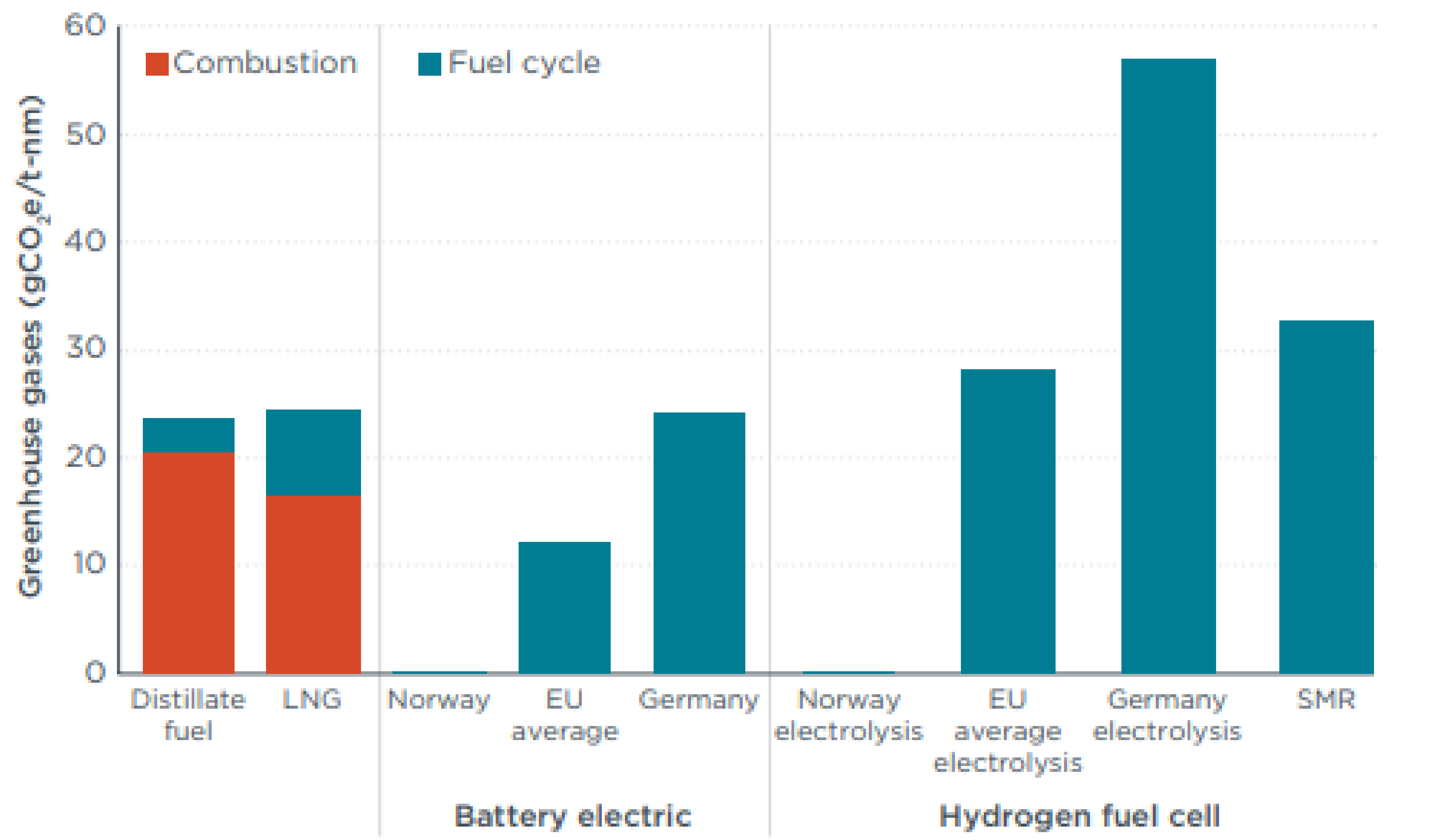


Figure 3. Greenhouse gas emissions by technology for an example small container ship.

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used, the results for hydrogen are highly sensitive to the efficiency of the fuel cell and hydrogen electrolyzer. For example, with a SOFC with heat recovery, total efficiency could increase to 85% (up from 60% in the PEM case in the figure), making hydrogen from average European electrolysis cleaner than the baseline fuels. Additionally, the performance of LNG here assumes complete combustion with no methane slip; if this were not the case, the impacts would be substantially higher. We use a 100-year global warming potential; using a shorter time horizon would show higher emissions from the LNG ship, as methane has disproportionate near-term climate impacts. Although not shown here, using heavy fuel oil would result in greenhouse gas emissions up to 20% higher than distillate fuel because of relatively higher black carbon emissions, depending on ship type and the time scale used in accounting. We excluded ammonia fuel cells from the figure because of the greater degree of uncertainty and lack of experience with ammonia as a transportation fuel. Ammonia is produced from hydrogen but requires additional processing; our best estimate from the literature suggests that ammonia fuel cell paths would add 5 to 10 gCO_2/t-nm to similar hydrogen fuel cell pathways shown in Figure 3.

Maritime shipping benefits from very low fuel prices relative to other forms of transport. We estimated the fueling costs associated with the same example feeder container ship above to place these zero-emission technologies into a broader cost perspective. Distillate fuel costs an equivalent of $2.17/gallon (€0.47/liter) as of March 2018, compared to $0.67/kg for LNG fuel. These values translate to $0.40/t-nm for distillate fuel and $0.43 for LNG for the example vessel considered above. We compared these conventional costs to the zero-emission technologies on the basis of electricity rates for industrial customers in selected markets and hydrogen used in International Energy Agency projections for 2020.[37] The cost of fueling the electric ship in Norway would be 60% lower per tonne-nautical mile than distillate, and European average electric costs would be 10% lower. If hydrogen costs drop

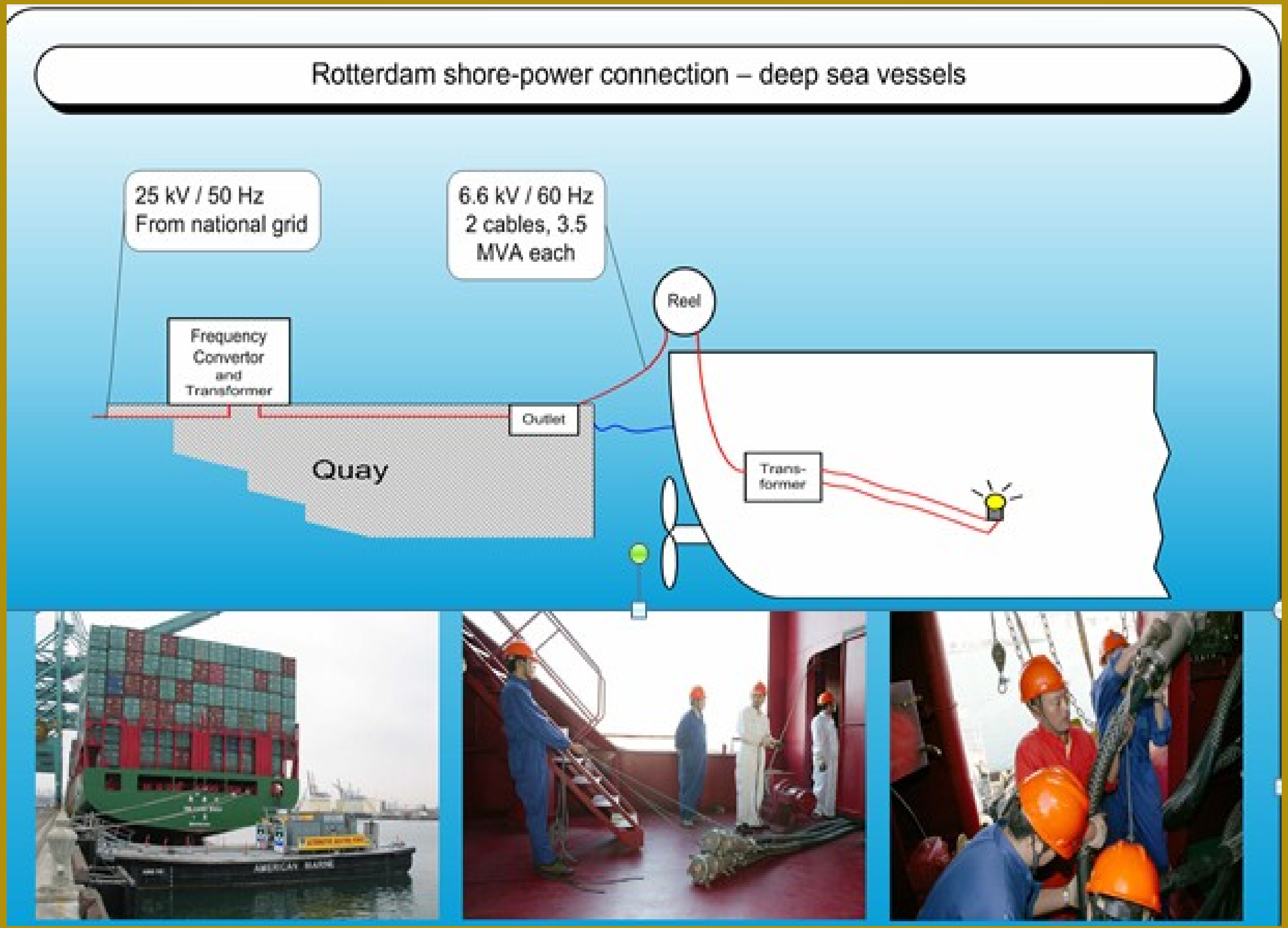
37 We assume $15.87 per MMBtu of LNG and $4.83 and $8.54 per kg of liquid hydrogen from SMR and renewable electrolysis, respectively, based on IEA projections for 2020.

Conexión a la red eléctrica (Onshore Power Supply OPS)

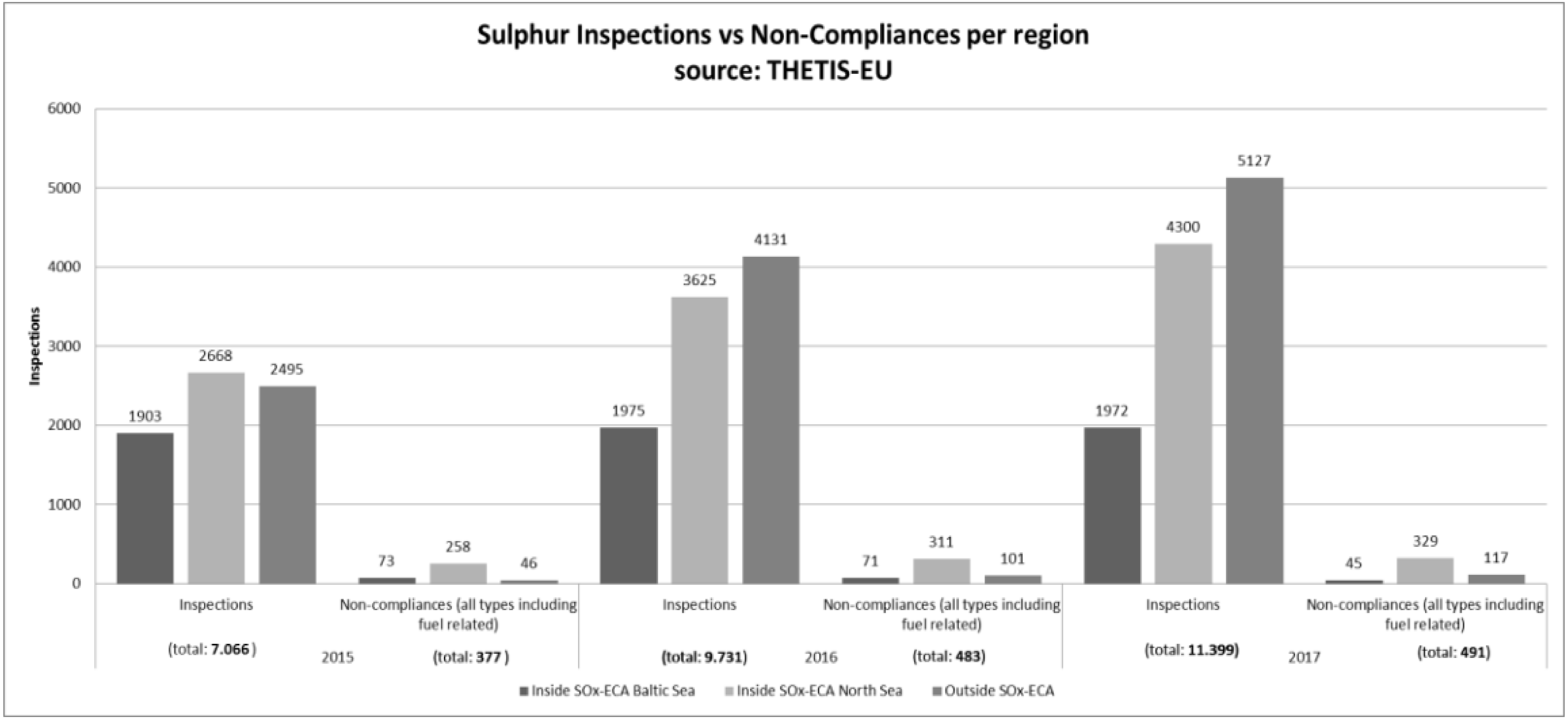
Ports using OPS

Ports using OPS systems have been developed in North America as well as Europe for seagoing ships. As the following table illustrates, the absence of pertinent standards and differences in electrical layouts of grids and ships have resulted in differences in several aspects.

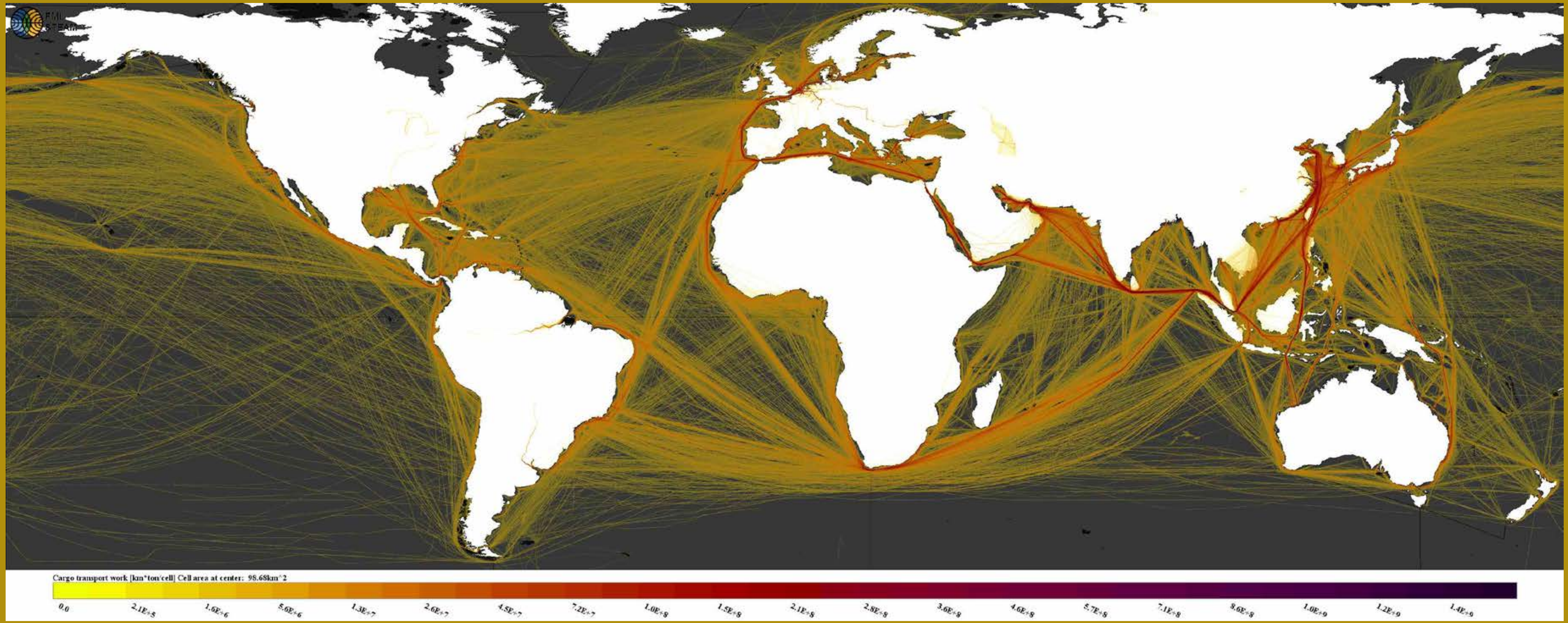
Port	Country	High Voltage	Low voltage	Frequency
Antwerp	Belgium	6.6 kV		50 Hz/60 Hz
Goteborg	Sweden	6.6 kV/10 kV	400 V	50 Hz
Helsingborg	Sweden		400 V/440 V	50 Hz
Stockholm	Sweden		400 V/690 V	50 HzV
Piteå	Sweden	6 kV		50 Hz
Kemi	Finland	6.6 kV		50 Hz
Oulu	Finland	6.6 kV		50 Hz
Kotka	Finland	6.6 kV		50 Hz
Lübeck	Germany	6.6 kV		50 Hz
Zeebrugge	Belgium	6.6kV		50 Hz
Los Angeles	U.S.A	6.6 kV/11 kV		60 Hz
Long Beach	U.S.A	6.6 kV	480 V	60 Hz
San Francisco	U.S.A	6.6 kV/11 kV		60 Hz
San Diego	U.S.A	6.6 kV/11 kV		60 Hz
Seatlle	U.S.A	6.6 kV/11 kV		60 Hz
Juneau	U.S.A	6.6 kV/11 kV		60 Hz
Pittsburg	U.S.A		440 V	60 Hz
Vancouver	Canada			
Oslo	Norway	6.6kv		50Hz
Rotterdam	Netherlands	6.6kv		50Hz



Mejora control cumplimiento directivas



Mediterráneo



23.778 barcos operan en el Med.
10.000 diariamente.

Table 5: Fuel mix percentages for the Mediterranean Sea Area in 2016 and under MARPOL VI and Med ECA scenarios

Fuel Allocation	Pre-MARPOL VI Baseline Fuel Mix	MARPOL VI Fuel Mix	Med ECA Fuel Mix
MGO	2.8%	3.1%	97.7%
MDO	17.2%	95.5%	1.0%
HFO	78.8%	0.6%	0.6%
LNG	1.3%	0.8%	0.8%

- **325 millones de personas vive en núcleos urbanos costeros (145 en UE)**
- **Alta vulnerabilidad región.**
- **Aumento tráfico marítimo hasta un 250% en el año 2050.**

Factores

- Combustible utilizado.
- Motores naves.
- Alimentación en puerto.
- Proximidad puerto-ciudad.
- Actividad portuaria.
- Calidad aire nucleos urbanos costeros.

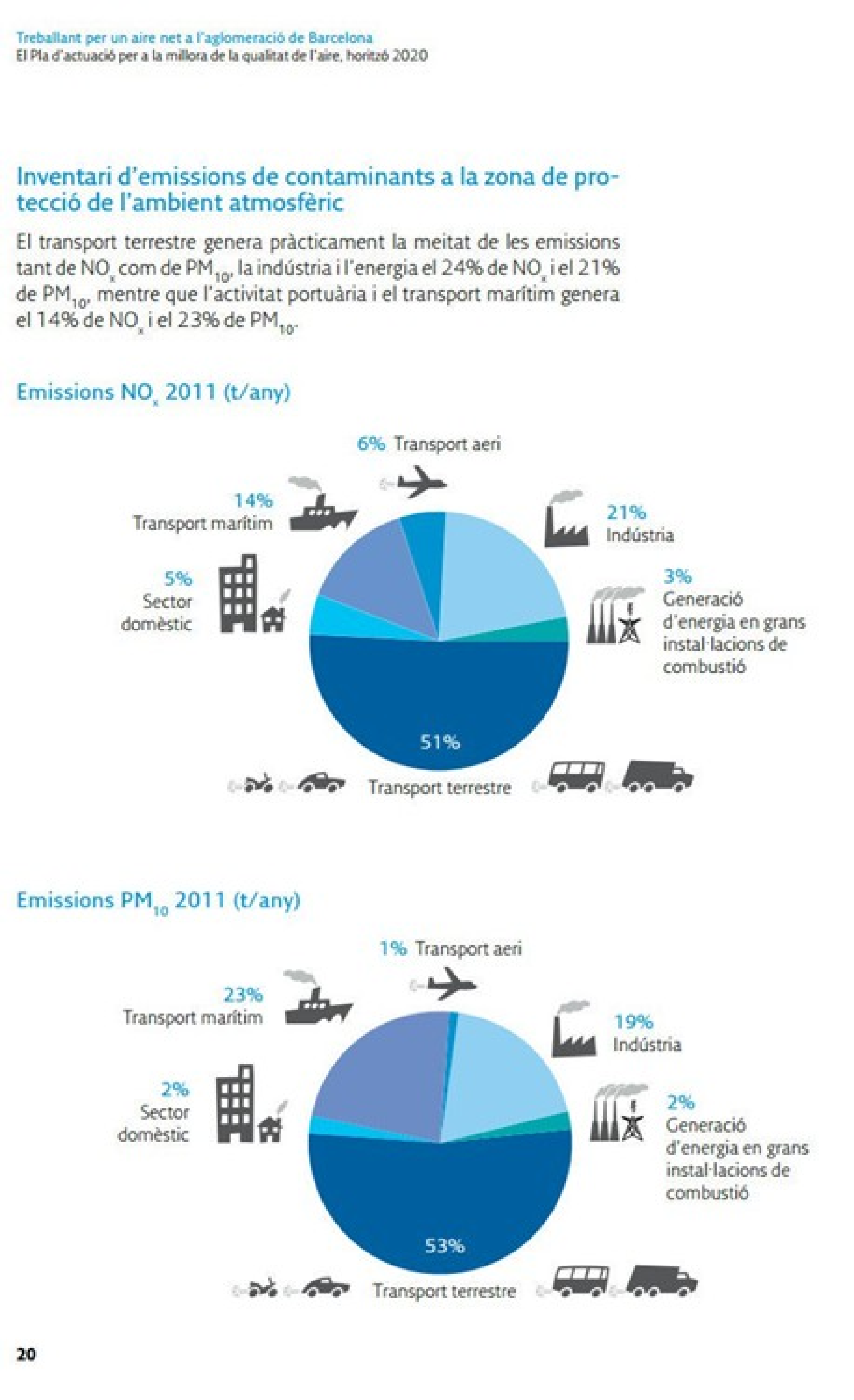
Impacto

- Emisiones GEI y contaminantes del aire.
- Inmisiones.

¿Dónde estamos?

El tráfico marítimo internacional representa el 40% emisiones NOx, el 44% SOx y el 22% PM2,5, referidas al total del Estado español en el año 2016. Datos Gobierno de España.

Foto. Betevé temps 2018



Treballant per un aire net a l'aglomeració de Barcelona
El Pla d'actuació per a la millora de la qualitat de l'aire, horitzó 2020

Inventari d'emissions de contaminants a la zona de protecció de l'ambient atmosfèric

El transport terrestre genera pràcticament la meitat de les emissions tant de NO_x com de PM_{10}, la indústria i l'energia el 24% de NO_x i el 21% de PM_{10}, mentre que l'activitat portuària i el transport marítim genera el 14% de NO_x i el 23% de PM_{10}.

Emissions NO_x 2011 (t/any)

Emissions PM_{10} 2011 (t/any)

20

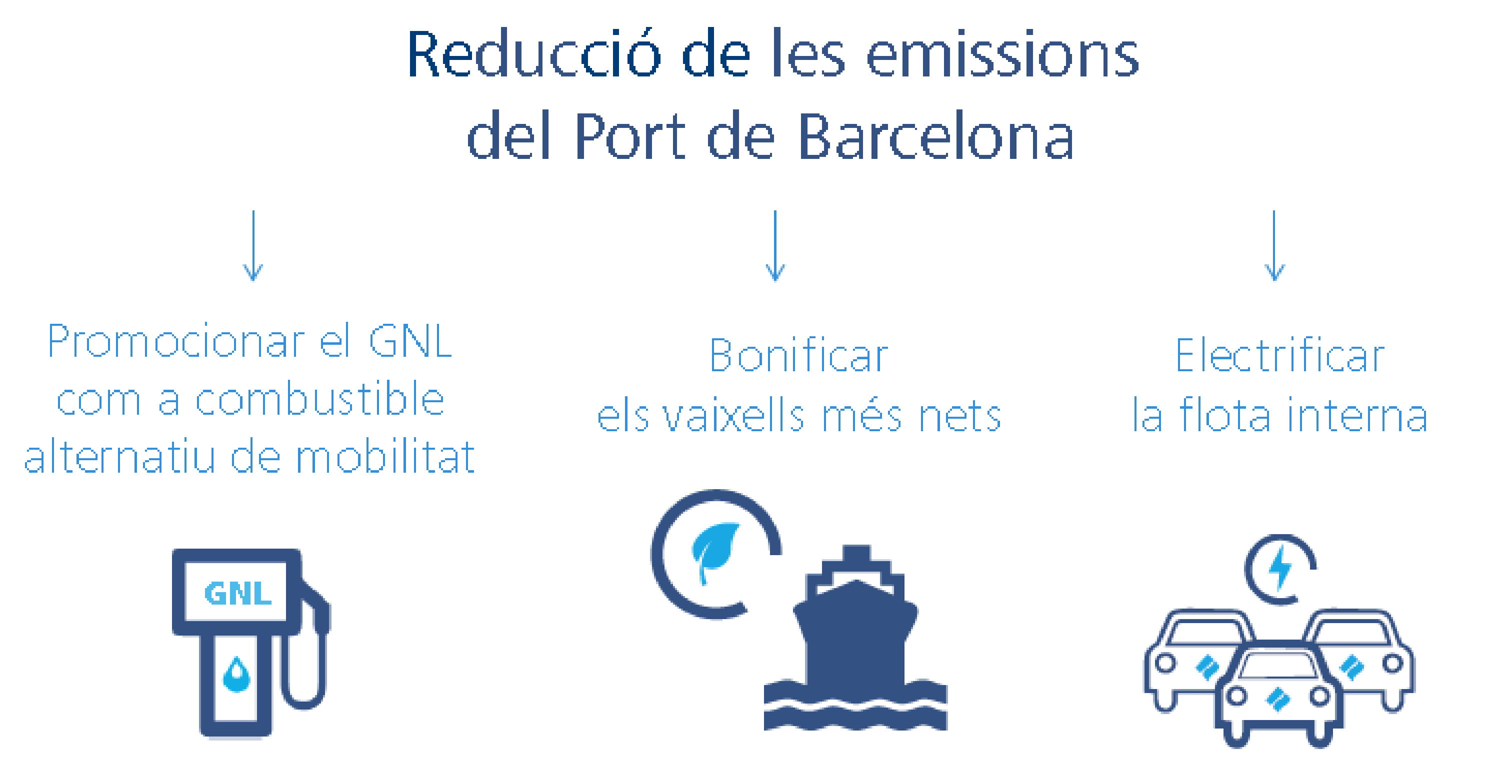
El caso de Barcelona

3. Estimació de les emissions generades per l'activitat portuària

	EMISSIONS **NOx** (TN/ANY)	% del total	EMISSIONS **PM10** (TN/ANY)	% del total
Vaixells	**5.116,0**	**92%**	**489,59**	**97%**
Portacontenidors	1.554,1	28%	148,06	29%
Cargo	1.804,9	33%	182,75	36%
Creuers	693,2	12%	62,40	12%
Ferri	686,8	12%	70,33	14%
Altres vaixells	377,0,	7%	26,05	5%
Vaixells auxiliars	**234,8**	**4%**	**5,35**	**1%**
Maquinària auxiliars	**80,6**	**1%**	**5,13**	**1%**
Circulació de vehicles	**114,4**	**2%**	**5,61**	**1%**
Total	**5.545,8**	**100%**	**505,68**	**100%**

FONT: BARCELONA REGIONAL

5. Pla de Millora de la Qualitat de l'Aire. Principals accions



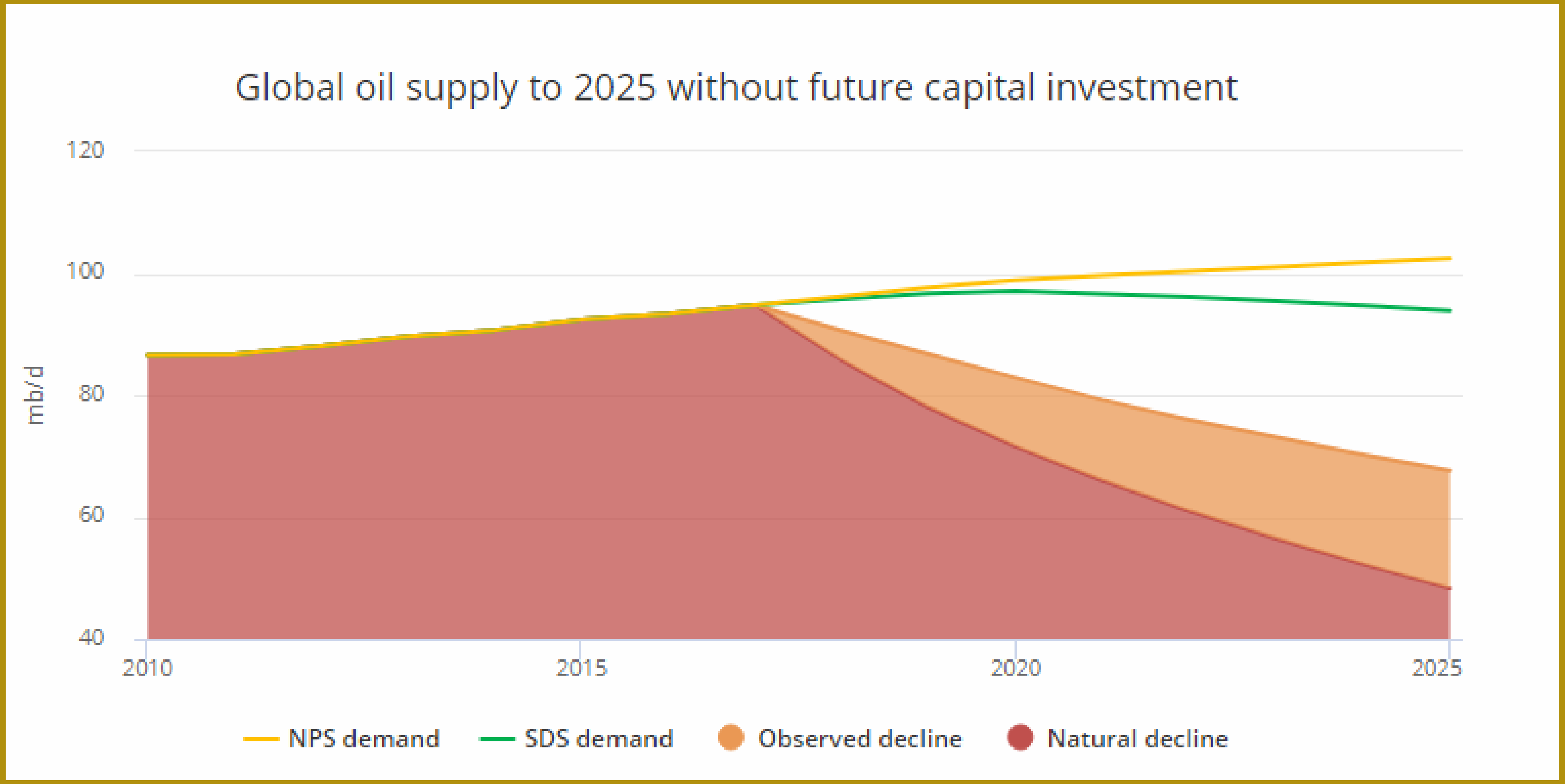
Nuevas ampliaciones previstas:

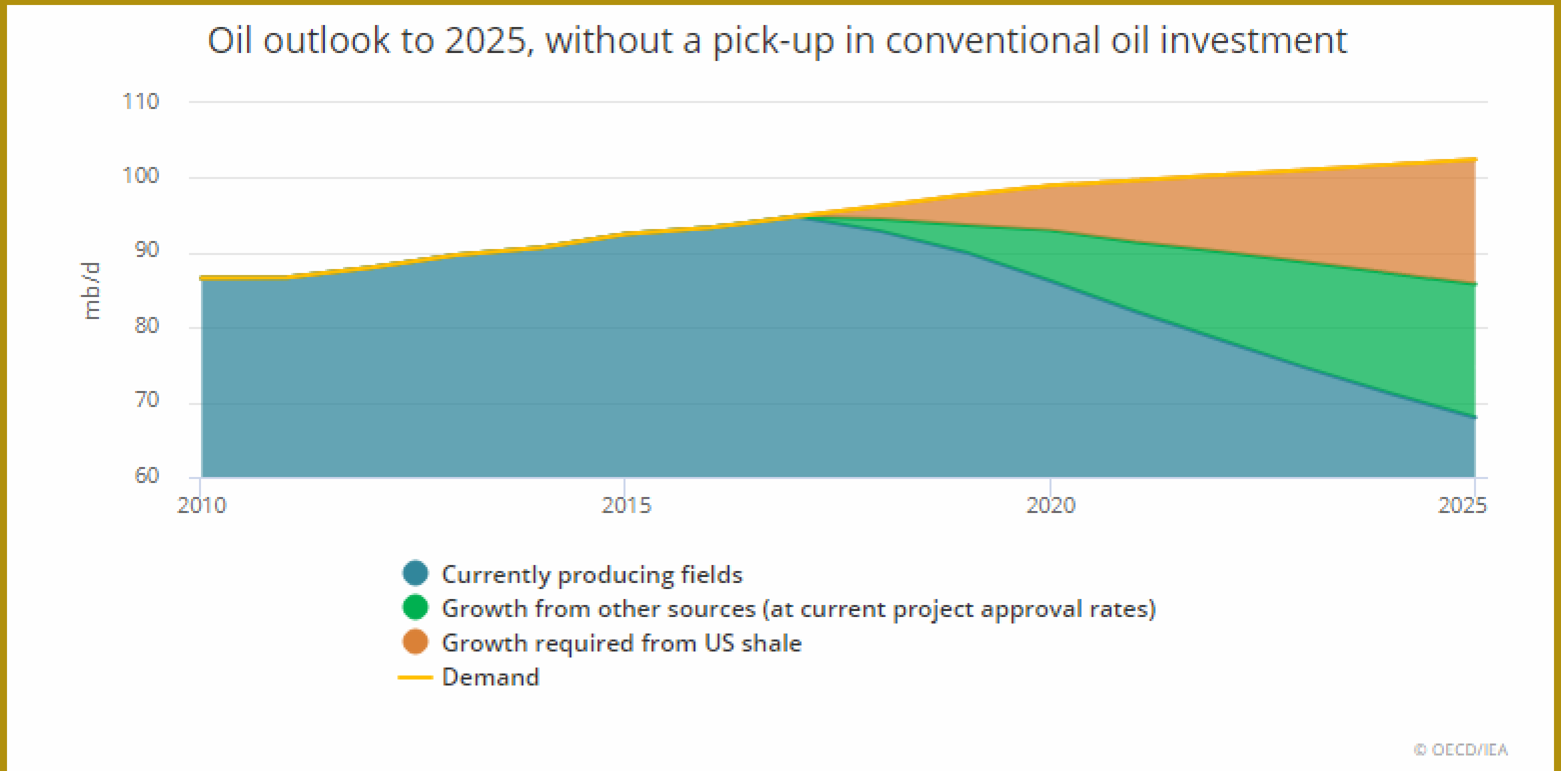
- 2 nuevas terminales de mega- cruceros (3 millones cruceristas en 2018 : +12% del 2017)
- Ampliación 3ª terminal carga (3 millones a 5 millores de contenedores).

Retos BCN

- Calidad del aire
- Descarbonización
  - IMO 40% reducción intensidad carbono (emisiones por t-nm) en 2030 y reducción 50% GEI en 2050.
  - UE 40% de reducción de las emisiones GEI en 2030 en relación con los niveles de 1990
  - Ley catalana de cambio climático
    - Presupuestos de carbono por sectores y cada 5 años
    - Artículo 21. (3). Evaluación GEI proyectos constructivos y ECA en puertos Generalitat.
    - Artículo 21. (4). ECA en puertos Generalitat.
    - Artículo 24. (4): Reducción en un 50% la dependencia de los combustibles fósiles puertos de mercaderías y deportivos en el año 2040.
    - Artículo 39. Impuesto sobre las emisiones portuarias de grandes barcos (NOx)

Escenario agotamiento del petróleo





What if demand were to follow a different trajectory?

In the Sustainable Development Scenario, with concerted action to reduce greenhouse gas emissions to meet the objectives of the Paris Agreement, demand peaks in the early 2020s and falls by 1 mb/d between 2017 and 2025. We do not yet see the policies in place or on the horizon that would lead to this outcome (if we did, they would be incorporated already in the New Policies Scenario), but it is of course possible that a lower demand trajectory also helps to avoid the risk of market tightening in the 2020s.

Demandas

- **ECA en el mar Mediterráneo en 2020** para todos los contaminantes (Sox, NOx, PM y carbono negro).
- **Prohibición del uso de *scrubbers*** en el mar Mediterráneo. Incorporación filtros de partículas y SCR Nox.
- Esquema armonizado y eficaz de **control y aplicación de la regulación**.
- **Conexión eléctrica** en puertos (OPS)
- **Supeditar nuevos proyectos de ampliación** a cumplimiento niveles OMS calidad del aire y objetivos de reducción GEI (directivas europeas y leyes de cambio climático).