



Høgskulen  
på Vestlandet



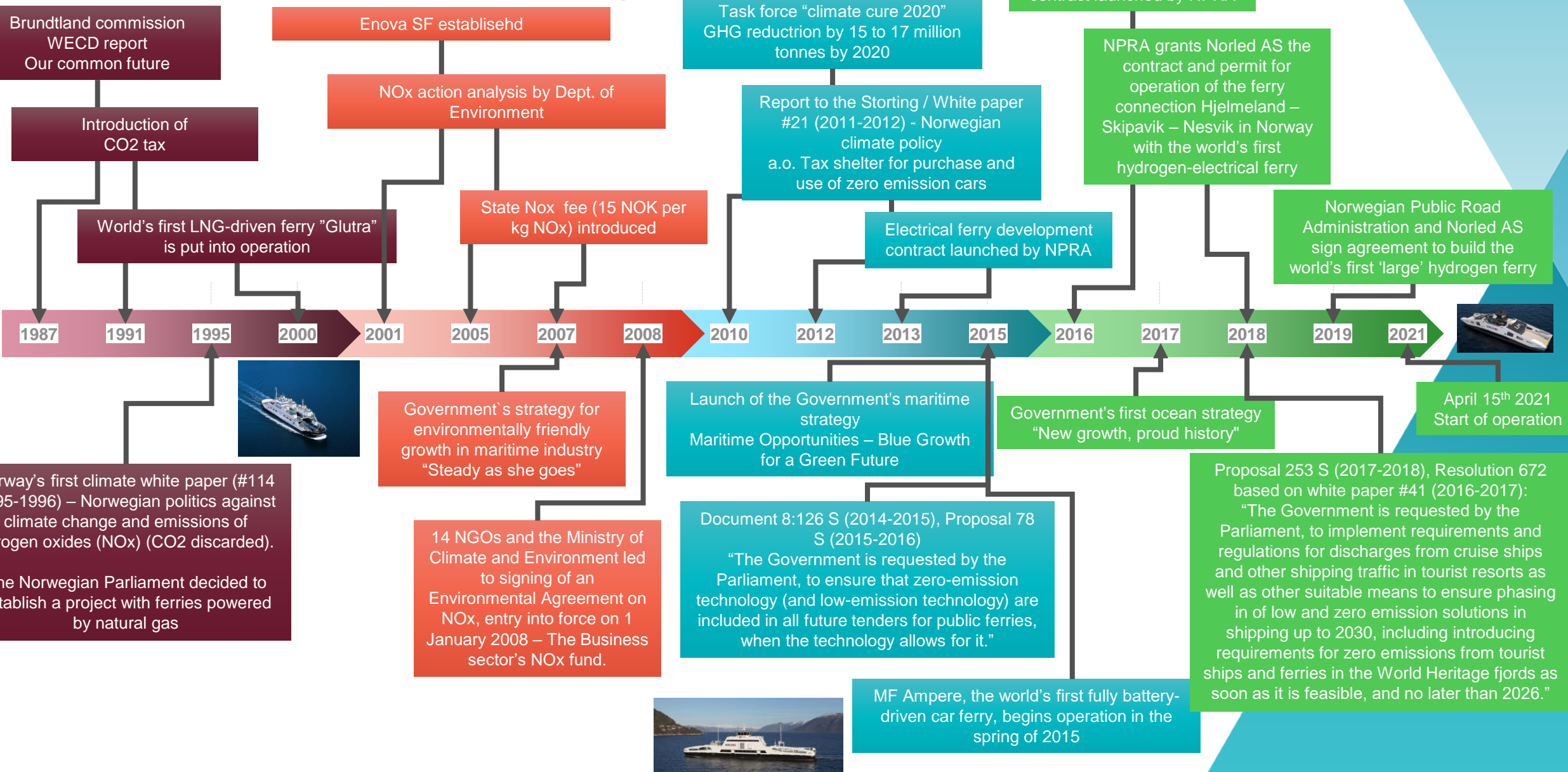
# Zero emission (short sea) shipping – a recap of the Norwegian way

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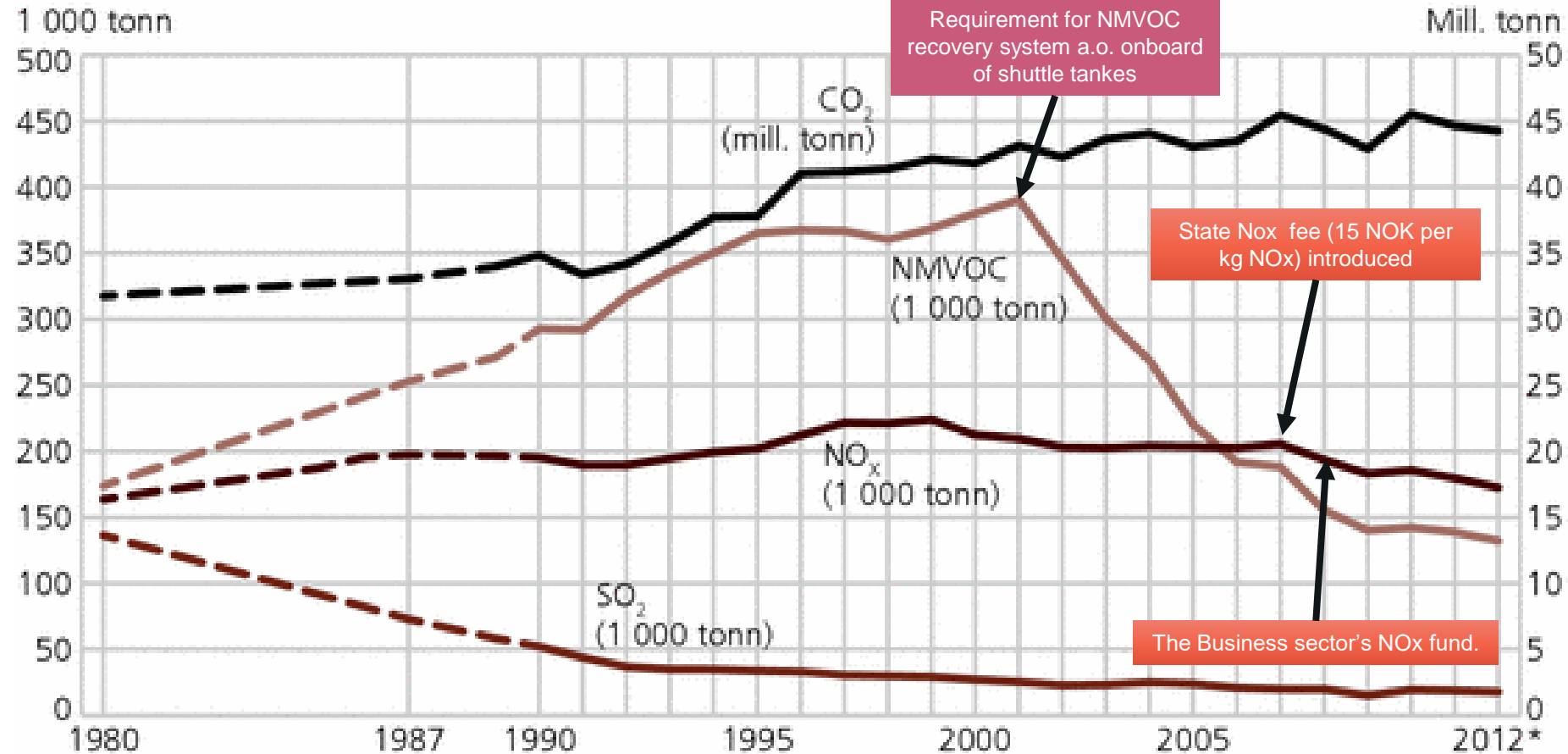
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# A selective view back (and forth)

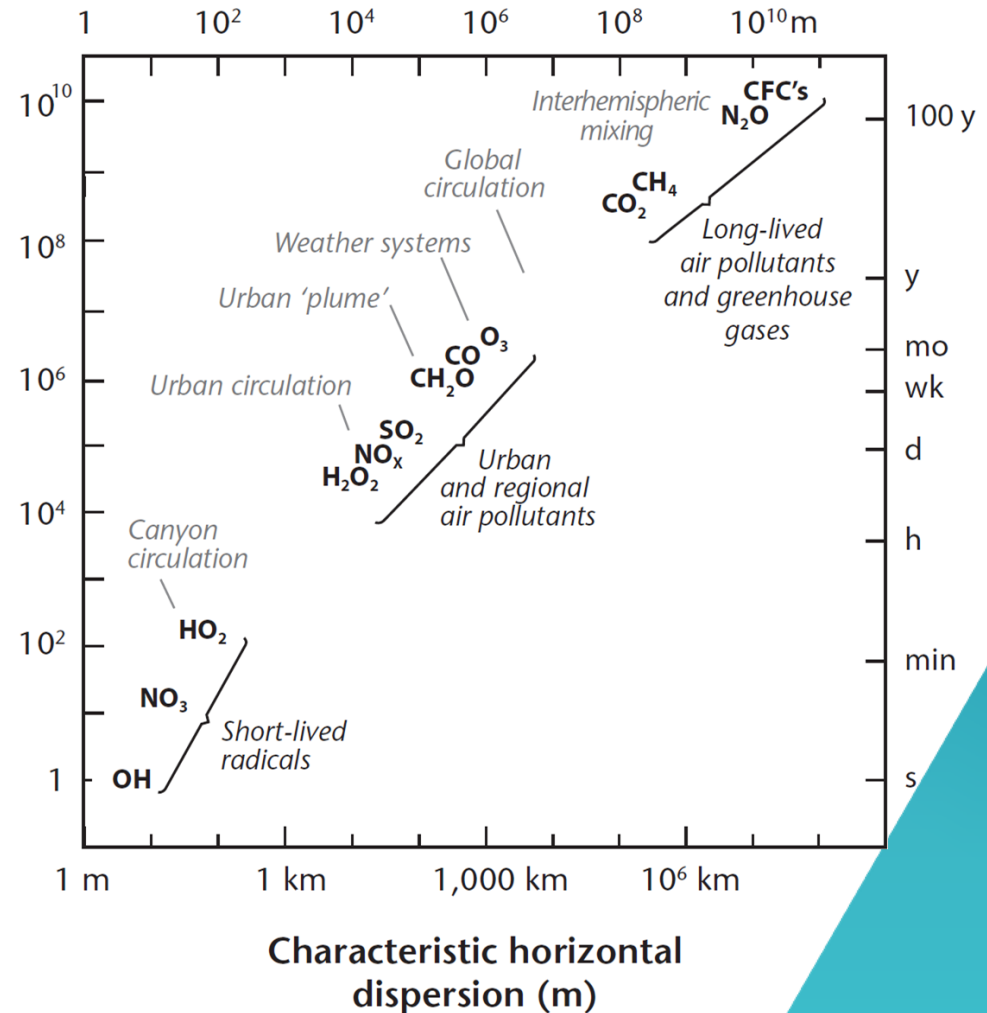
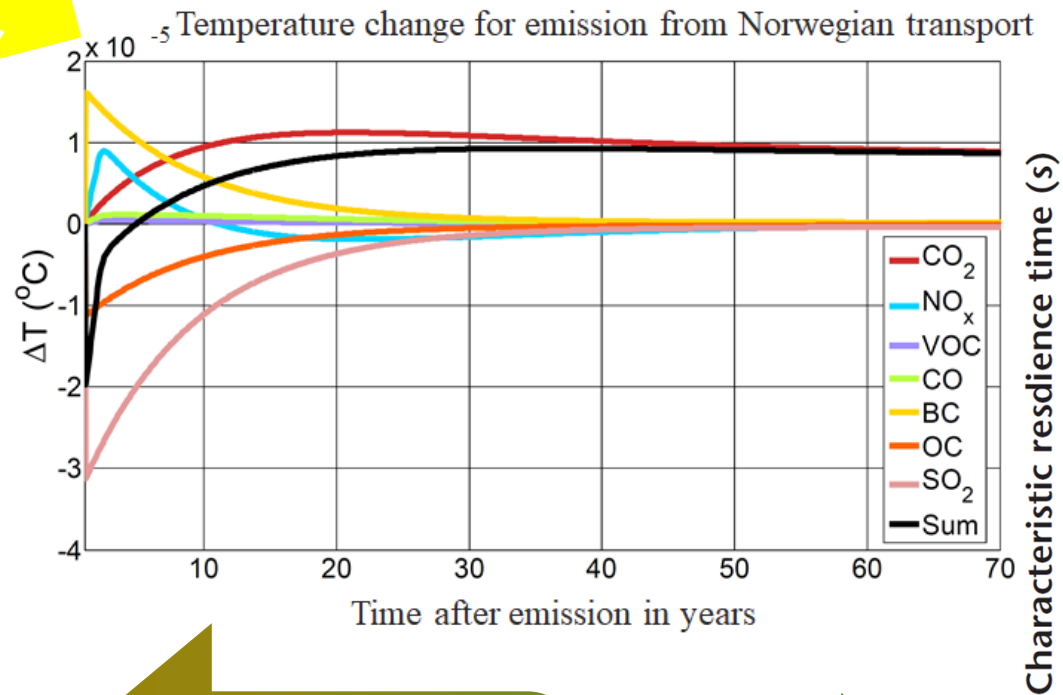


# Norwegian emissions historically



Excluding foreign shipping and air traffic

# Zero what? The importance of scale



Environment

Climate

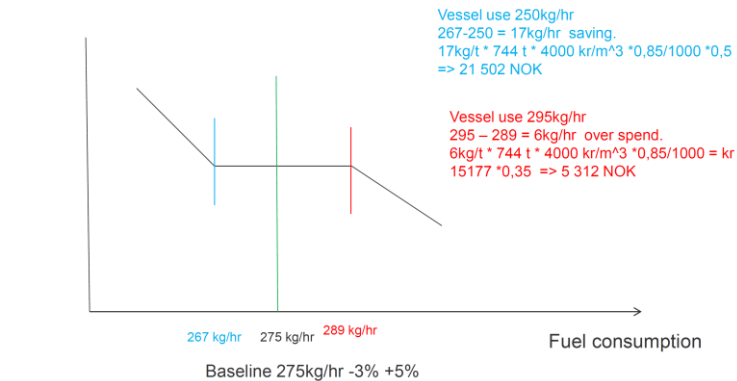
Source: Oke, T., Mills, G., Christen, A., & Voogt, J. (2017). Air Pollution, Urban Climates, 294-331

Aamaas B, Peters G P, Fuglestedt F S (2013b). Simple emission metrics for climate impacts. *Earth Syst. Dynam.* **4** 145-170.

# Innovation tool-shed

Subsidy scheme	TRL	Phase in a (public) tender	Beneficiary
<b>NRF / RFF</b> (Norwegian Research Council)	1-3	<ul style="list-style-type: none"> <li>Requirement capture</li> <li>Market dialog</li> <li>Planning</li> </ul>	R&D and industry
<b>IN</b> (Innovation Norway)	4-5	<ul style="list-style-type: none"> <li>Market dialog</li> <li>Requirement for development</li> </ul>	Industry
<b>Enova SF</b> (Energy Efficiency Agency)	5-7	<ul style="list-style-type: none"> <li>Pre-commercial procurement with development and testing</li> </ul>	R&D and industry
<b>NOx fund</b>	7-9	<ul style="list-style-type: none"> <li>Innovative procurement</li> <li>Implementation</li> </ul>	Participating industry only

## Incentive model



8 Classification: Internal 



# Some NOx fund numbers\*

**1200**

Number of projects receiving funding

**9 billion NOK**

Granted funding, over 50% already disbursed

**20 - 30 billion NOK**

Worth of NOx reduction measures investment

**5000 to 566.000.000 NOK**

Span of project support funding

**7-8.000.000 NOK**

Average support by project  
(80% of all projects at or below)

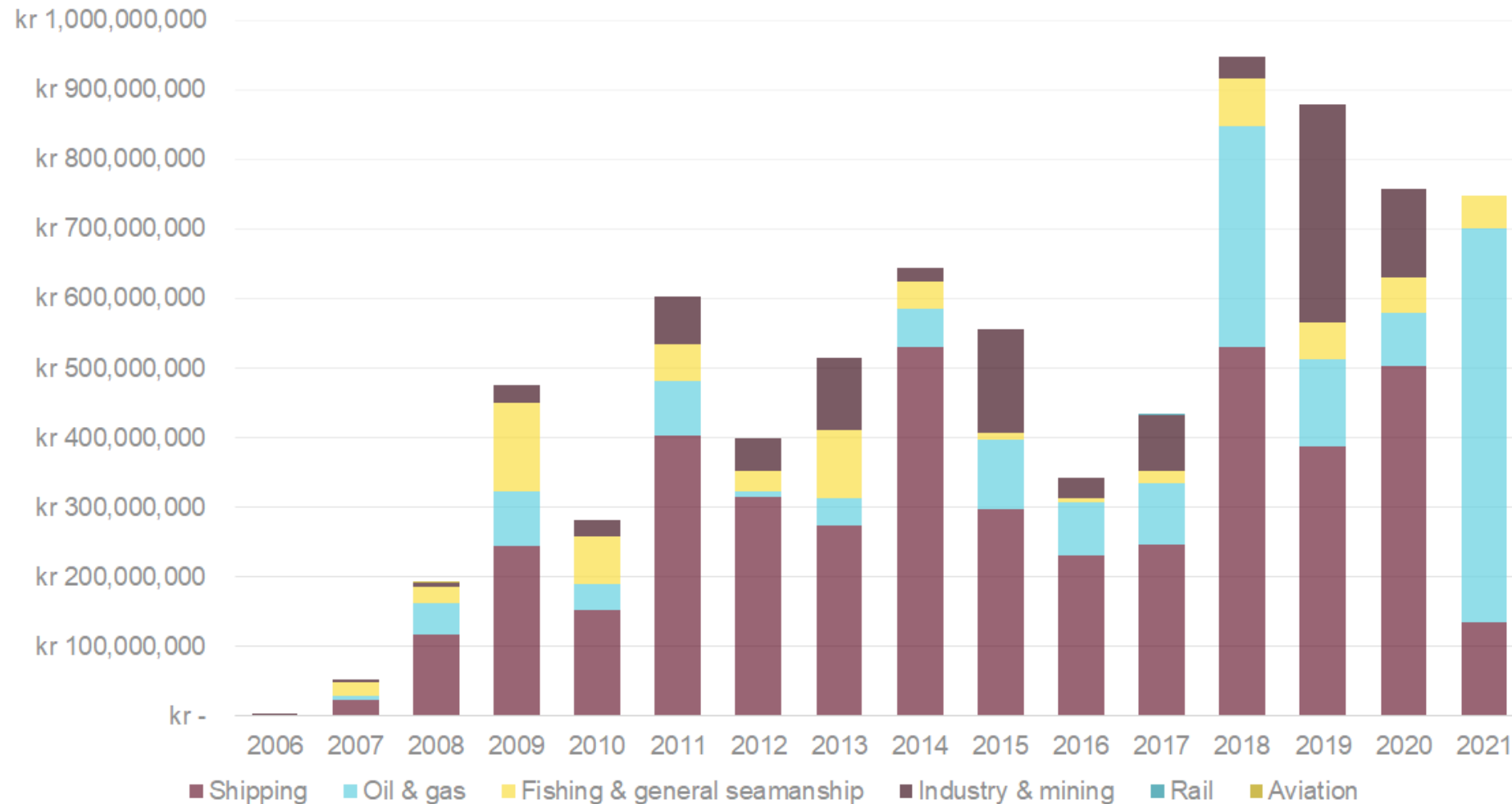
**40 – 50.000 t NOx**

Accumulated annual reduction

**Ø 170 NOK/kg NOx**

Average effective support rate

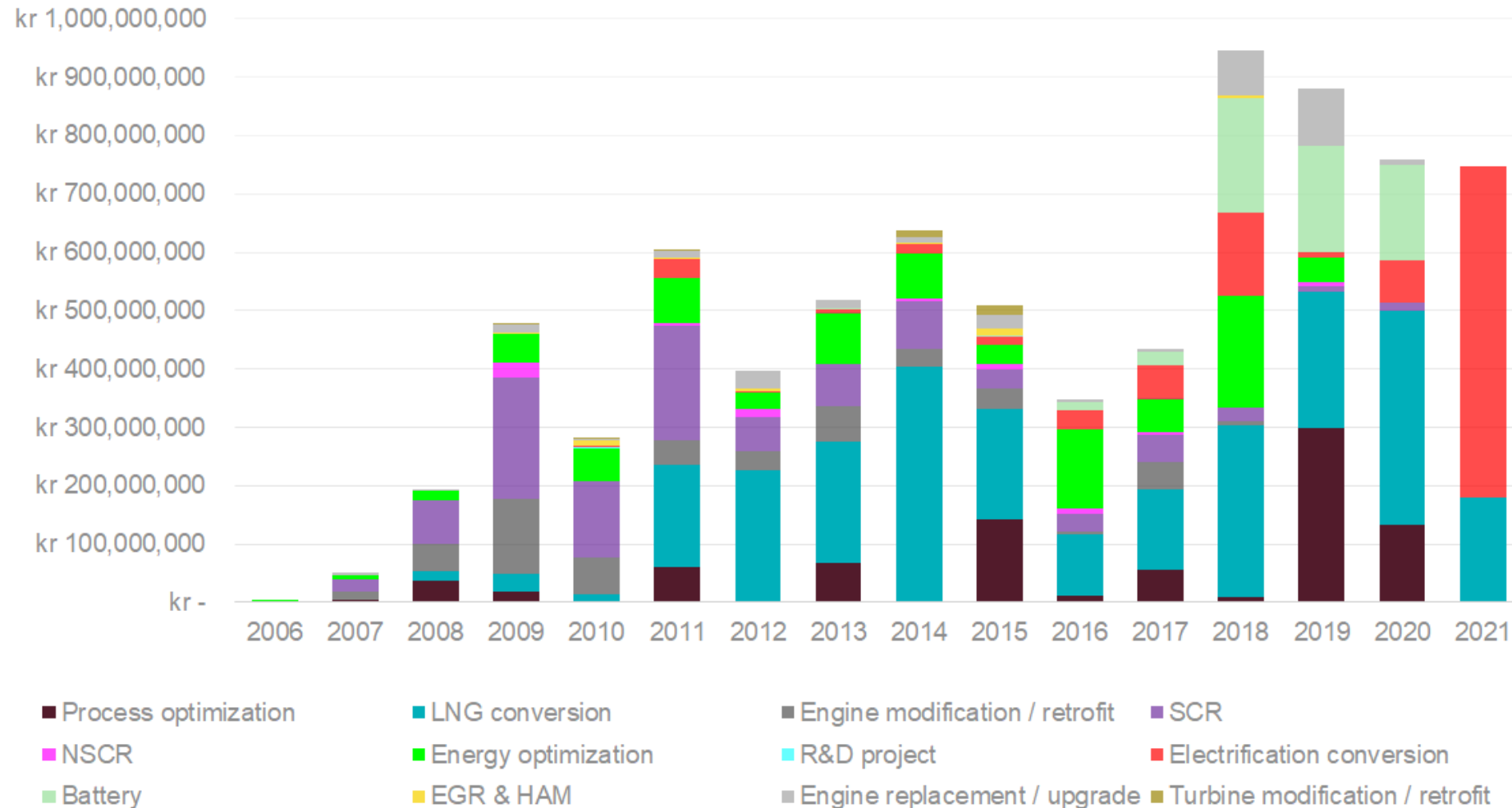
# NOx fund by industry



Source: <https://www.nho.no/samarbeid/nox-fondet/>



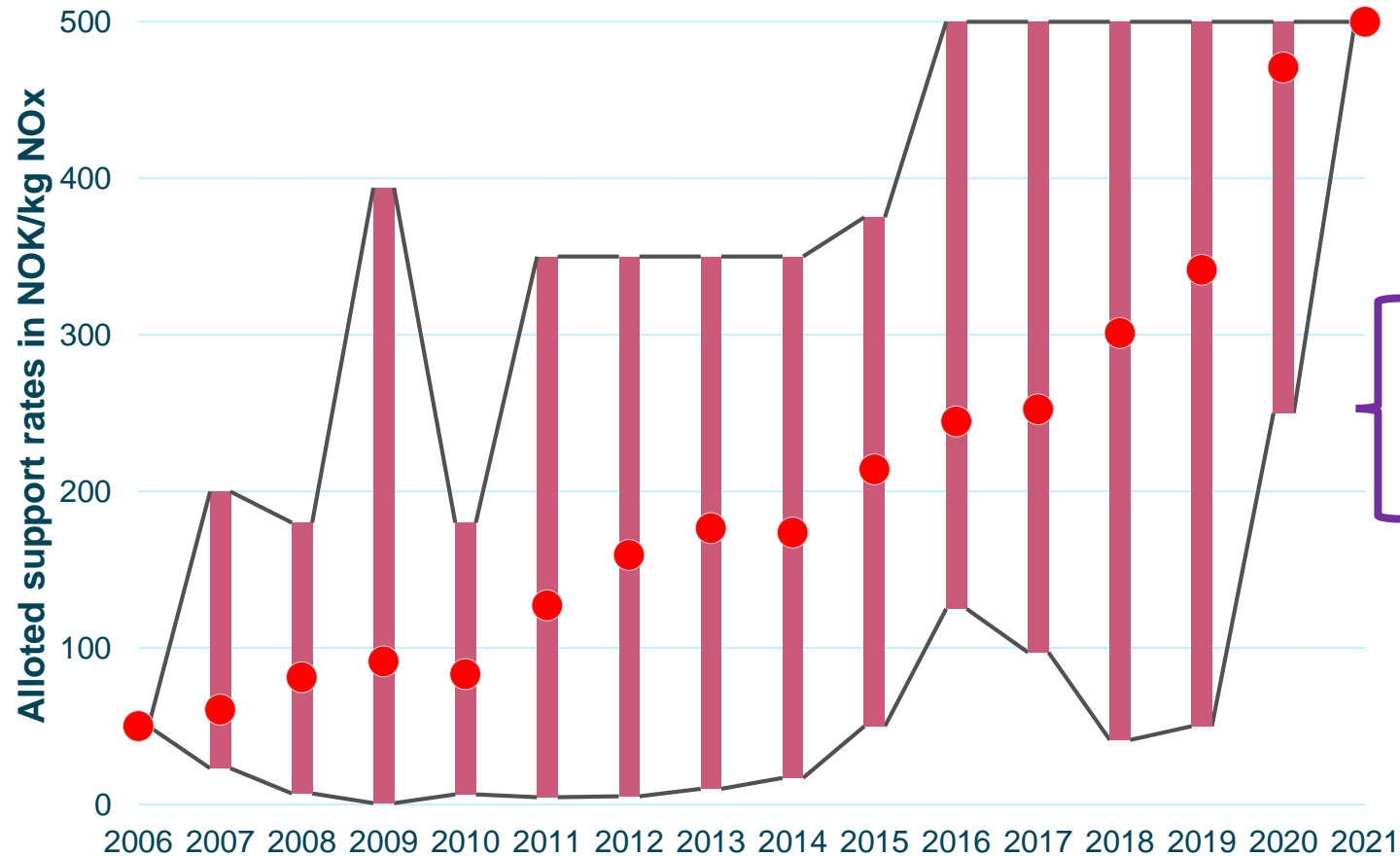
# NOx fund by measure



Source: <https://www.nho.no/samarbeid/nox-fondet/>



# NOx fund support rates



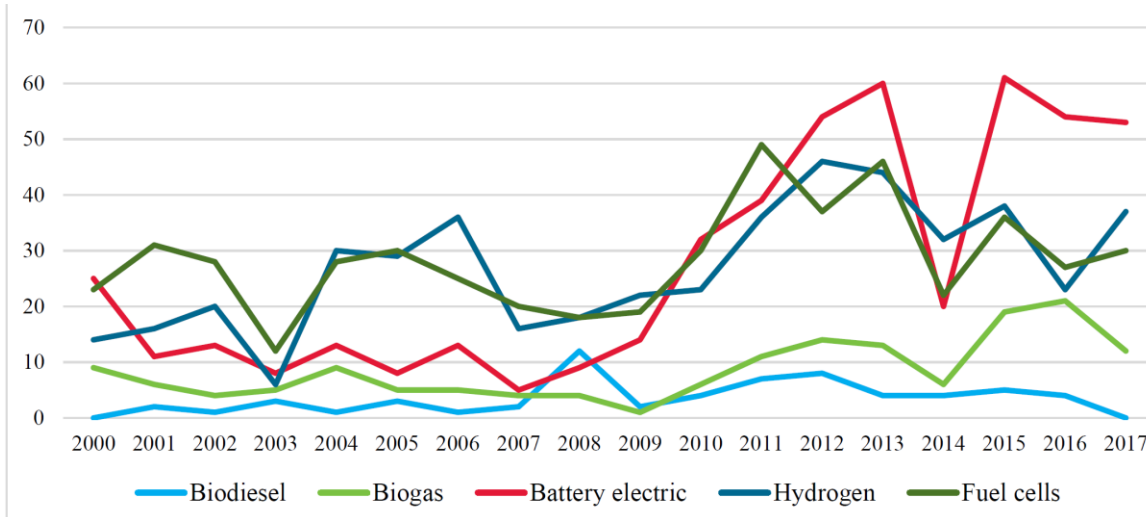
- Energy : LNG, electrification & hydrogen
- Battery
- SCR/SNCR (stationary sources)
- Reduction of NOx from flaring and offshore gas turbines
- Optimization of processes in landbased industries
- Energy efficiency measures combined with IMO Tier 3 measures
- Engine replacement combined with IMO Tier 3 measures

- SCR, EGR and other NOx reduction measures (mobile sources)
- Shorepower (mobile sources)
- Energy efficiency measures
- Engine modification / retrofit

**Update 27.08.2019**  
New support rates (20% lower)  
and adjusted max.limit (80% → 70%)

# Team work makes the dream work

Network	No. of members	Biodiesel	Hydrogen + fuel cells	Battery electric
GCE Blue Maritime Cluster	141		X	X
Green coastal shipping programme	26	X	X	X
Norwegian Hydrogen Forum	44		X	
Maritime Battery Forum	45			X
NCE Maritime CleanTech	74		X	X



Source: Greening the fleet: A technological innovation system (TIS) analysis of hydrogen, battery electric, liquefied biogas, and biodiesel in the maritime sector, Sintef Ocean, 2019

# Potpourri of world's first / biggest ...



2000

- ~660 dwt Car ferry (100 cars, 300 passengers)
- 4 x LBSI Mitsubishi GS12R-PTK á 675 kW



2003

- ~6013 dwt Offshore supply vessel
- 4 x Wärtsilä 6L32DF á 2010 kW



2009

- ~6200 dwt Offshore supply vessel
- 4xWärtsilä 6L32DF, 2010 kW LPDF
- MTU Onsite Energy 320 kW PEM fuel cell
- Corvus energy 500 kWh battery package



2015

- ~199 dwt Car ferry (120 cars, ~350 passengers)
- Corvus energy 160 x Corvus AT6500 modules 1090 kWh & Siemens electrical motors 2 x 450 kW



2016

- 50,000 dwt Methanol carrier
- 7S50ME-B9.3-LGI ~12,5 MW



2019

- ~30.000 dwt RoPax (80 cars, 299 passengers)
- RR Bergen Engines 2 x B3345L6 (3,6 MW) + 2 x B3345L8 (4,8 MW) & Siemens battery packet 4,7 MWh

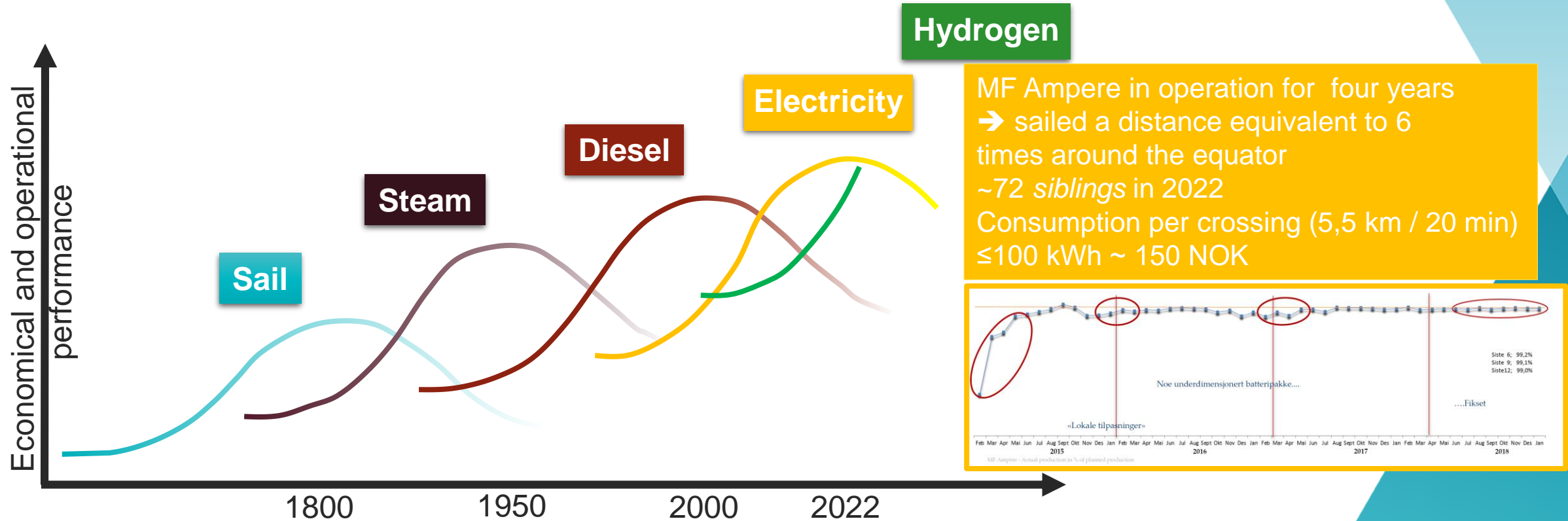


2021

- Car ferry (80 cars, 299 passengers)
- Ballard Power System fuel cell with Linde Engineering LH2 tank (at least 50% operation on LH2)



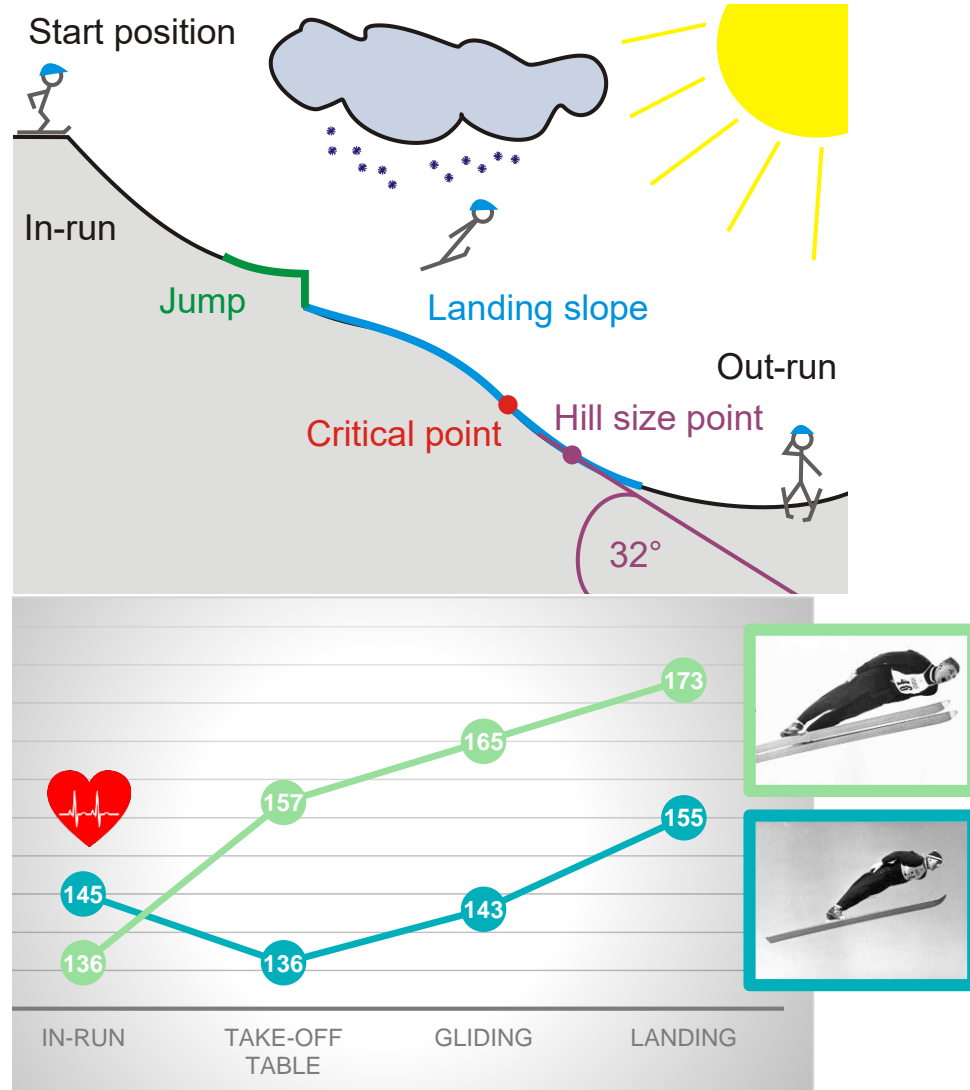
# Diffusion of shipping innovation



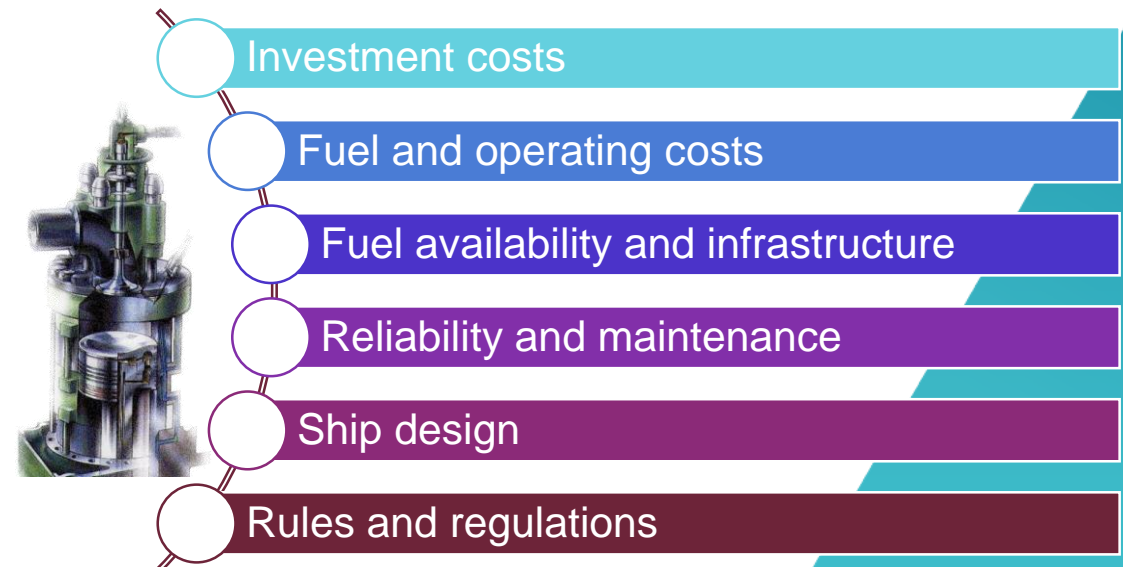
Paradigm shift for shipping ..?

Paradigm shift for short sea shipping!

# “Jumping after Wirkola”

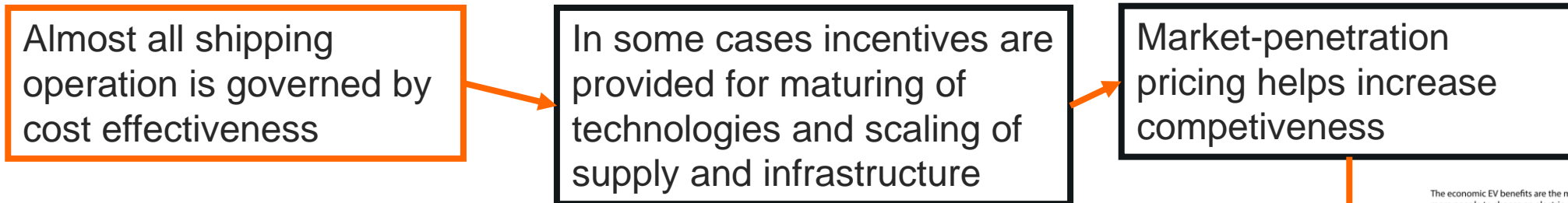


“The common parlance expression jumping after Wirkola has come to refer to situations where one embarks on a task where one's predecessor has done a particularly good job – or where one is unlikely to succeed.”





# Generation of green ships?



**Use of CO2 fund, tax, incentives ... to account for long term societal costs of climate change → EEDI 2.0**



#### Penalties for exceedances of targets:

- EUR 4250 per gCO<sub>2</sub>/tkm in 2025
- EUR 6800 per gCO<sub>2</sub>/tkm in 2030
- Significantly above the marginal cost of meeting the targets, and therefore deterrent for manufacturers.

The economic EV benefits are the most important to convince more people to choose an electric car



The Norwegian EV owner survey 2015: Rank the electric car incentives.

Norwegian EV Association



# The cabinet member, that just won't quit

