



The New Oil Rapid Marine Evolution in Norway


Brent Perry, PBES

Ship Emissions

The whale in the room we can no longer ignore

BELLONA

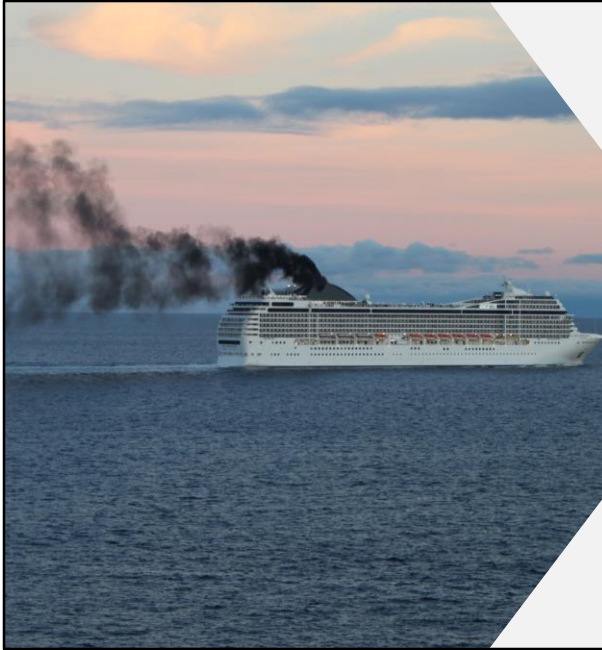




The Marine Industry is the best opportunity to make the biggest impact:

- Environmentally
- Financially

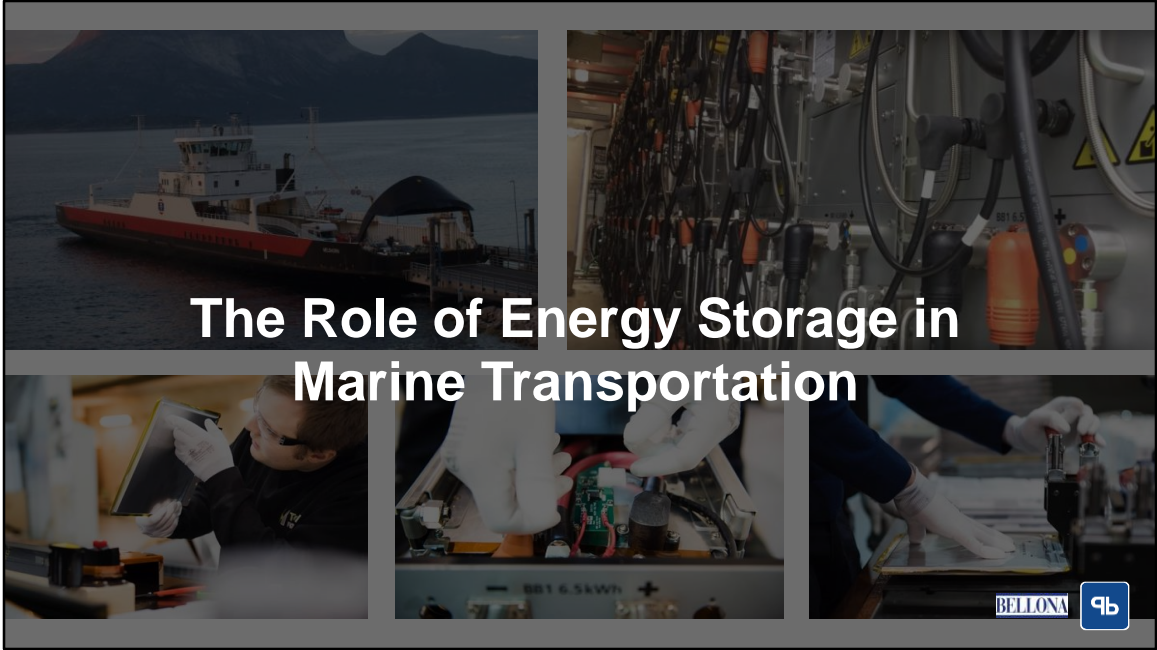
BELLONA 



Shifting the Focus to our Oceans

BELLONA





The Role of Energy Storage in Marine Transportation

ENERGY STORAGE

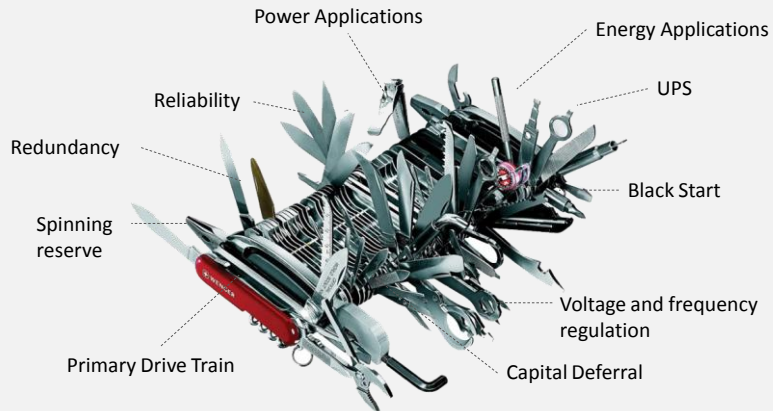
is

A (part of the) **Solution**

BELLONA



Energy Storage has Many Functions



BELLONA



- Redundancy
- Spinning reserve
- Reliability – reduce risk and better up-time
- Common loads
- Black Start
- Voltage and frequency regulation

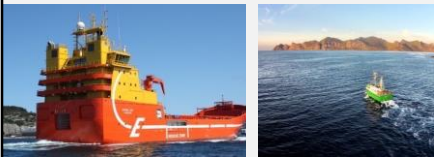
Fully integrated systems deliver a combination value proposition that leads to excellent ROI

Hybrid & Electric Ships

Environmental Accountability Rapid Return on Investment



Electric: Ferries, Port Equipment



Hybrid: OSV, Offshore Wind Farm Support, Ferries, Fishing boats

BELLONA



A Good Business Case



- Electric ferry Ampere is one of the most profitable ferries in Norway
- Ferry sector - 50 battery electric ferries to be built

BELLONA



In Norway and Denmark there are a lot of smaller ferries, where a recent survey has shown that it is not just environmentally a good case to convert to electrical propulsion, but also financially it is the right decision in close to 70 % on the existing routes.



The Power of Batteries

30 ferry routes in Denmark alone, would be more profitable with electric than diesel

BELLONA



PBES is scratching the surface with the initial projects we are working on with our customers- based on proven systems working today, energy storage is becoming a standard requirement

Excellent Characteristics for ESS



Safety:

- Safety and reliability through redundancy
- Black Start capability



Performance:

- Replace generator duties
- Full electric operation
- Optimizes diesel generator loading



Value:

- Reduce fuel consumption & emissions
- Reduce maintenance costs

BELLONA





The Power of Batteries

Technology is proven

*Tycho Brahe – All Electric Ferry
4.2MWh Lithium ion Battery*



Co-financed by the European Union
Trans-European Transport Network (TEN-T)

BELLONA



PBES is scratching the surface with the initial projects we are working on with our customers- based on proven systems working today, energy storage is becoming a standard requirement

Norway can reduce port emissions by 12.5 million tonnes

- 64 vessels with an operational profile suited to battery propulsion
- 97 different routes utilizing shore power
- 12,5million tonnes of CO₂ & 14million kg of NO_x emissions



Zero Emission Ports & Harbours

1. Tugboats and other support craft





Tugs

Demands over 60% loads only accounts for around 3% of the total time.

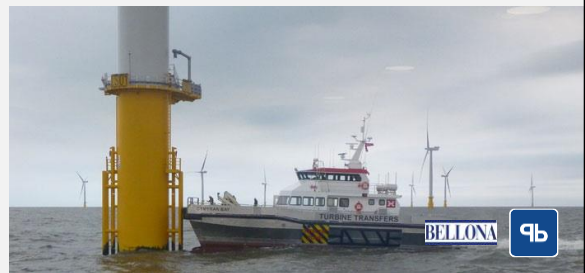
Task	Service	Knots	Time-(%)
Stand-by	Idle	0	15%
Transit-low	Transit	6.6	30%
Transit-high	Transit	10	7%
Assist-80%	Tow-pull-[80%]	1	1%
Assist-60%	Tow-pull-[60%]	1	1%
Assist-40%	Tow-pull-[40%]	1	9%
Assist-20%	Tow-pull-[20%]	1	26%
Barge-move-60%	Tow-pull-[60%]	5	1%
Barge-move-40%	Tow-pull-[40%]	5	1%
Barge-move-20%	Tow-pull-[20%]	5	9%

BELLONA



Wind Service Vessels

A new sector for energy storage technology.



Zero Emission Ports & Harbours

1. Tugboats and other support craft
2. Coastal Shipping and Ferry
Hybridization/Electrification



Coastal Shipping

Taking cargo from highly polluting road trucks to waterways

**Prime for
hybrid propulsion**



Zero Emission Ports & Harbours

1. Tugboats and other support craft
2. Coastal Shipping and Ferry Hybridization/Electrification
3. Shore Power – how batteries reduce burden on local grid and expand availability



Tycho Brahe

Plug-in electric ferry

Cables run from the deckhouses to connecting points at each end of the ship, so that the batteries can be quick-charged

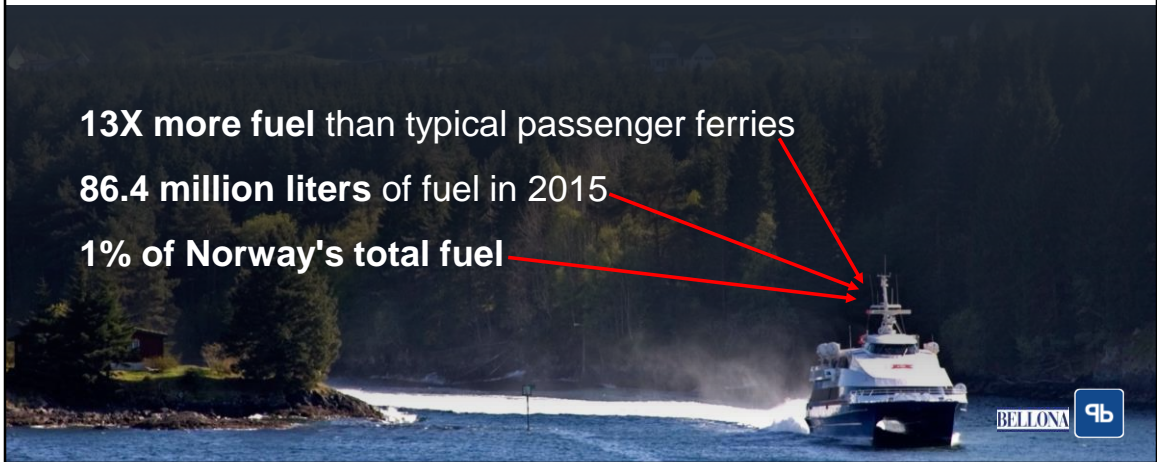


 Co-financed by the European Union
Trans-European Transport Network (TEN-T)

BELLONA



New Energy Storage Market

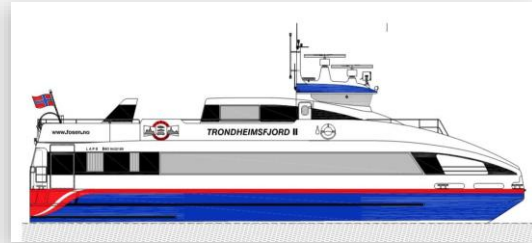


Ok we need to move this into a random look with the facts in large bold short word

Facts in center, actual facts around

New Energy Storage Market

- Save 800,000EUR/year
- Payback = less than 5 years
- Reduce 2200 tons CO² & 24 tons Nox / year



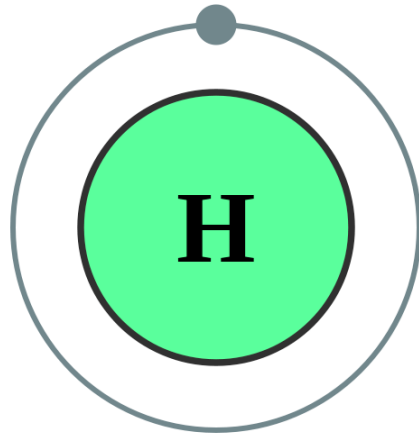
BELLONA



Hydrogen Fuel Cells

Hydrogen fuel cells

Hybrid battery/fuel system



Financial models of specific vessels



Victoria: Offshore Support



Tycho Brahe: Electric Ferry

BELLONA



Financial models of specific vessels



Vardehorn: Hybrid Ferry



Ampere: Electric Ferry

BELLONA





Why Norway

ROI makes sense

BELLONA



Norway's Commitment to Environmental Sustainability

Today Most sectors are experiencing a technological transition

Future By 2030, Norway is to reduce emissions by 40% from 2005 levels

Norway Will Achieve Climate Neutrality by 2030



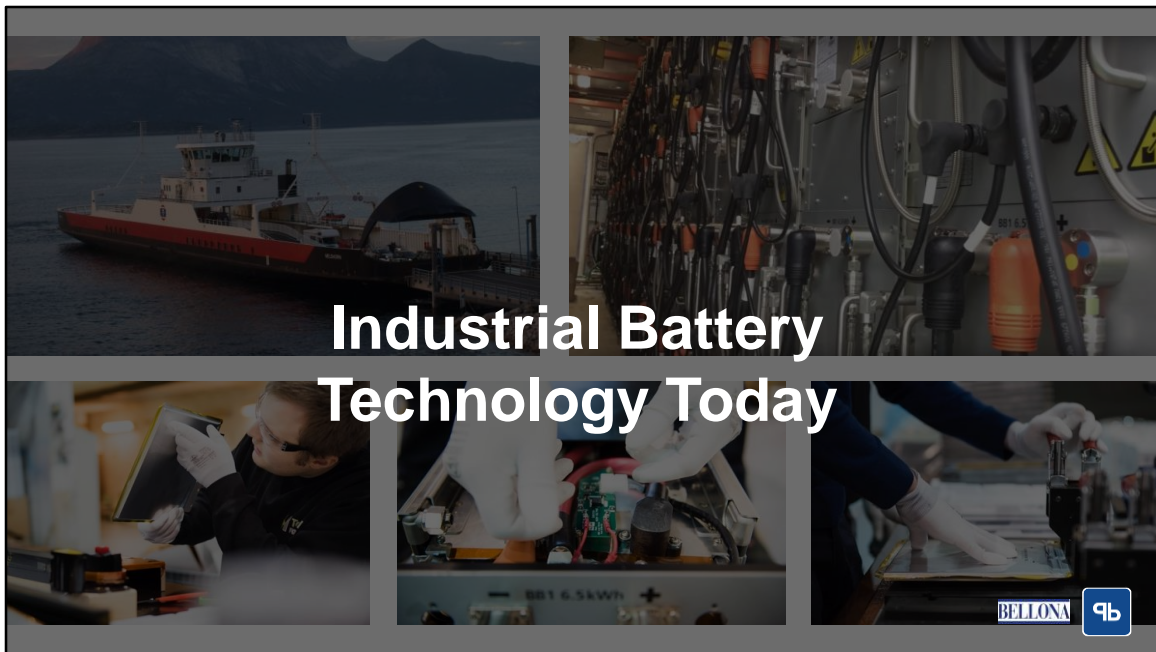
<http://www.azocleantech.com/article.aspx?ArticleID=558>

PBES - Norwegian Energy Storage

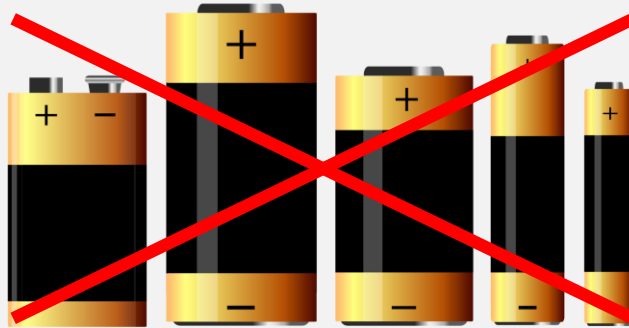
Zero emission solutions creating **green jobs and green growth**

- Industry partners
- Government and are proven leaders
- Volumes of growth now & prognoses for the coming year





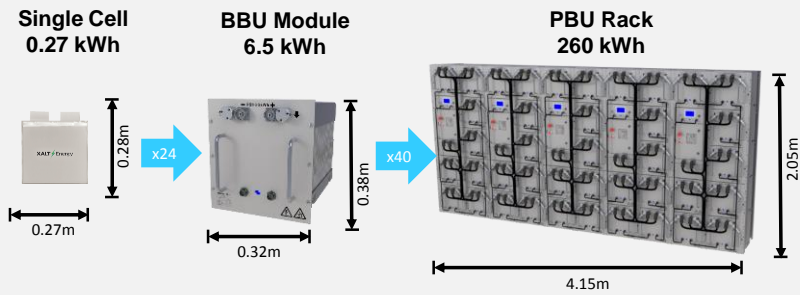
DON'T THINK BATTERIES



BELLONA



Think Solutions



BELLONA



Our ESS addresses safety at all levels
Cell – Module – System/Environment - Installation

Advancements In Technology



Can be charged in as little as 6 min.

BELLONA



New ESS systems can be fully charged from 0 in as little as 15 min and fully discharged in even less time. Allowing huge power from a smaller and smaller systems.

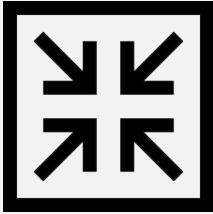
The System lifetimes are increasing, with some systems offering 4500 cycles at 100% Depth of Discharge and over 12000 at 80% Depth of Discharge, performance increases are the way of the future.

System costs are decreasing at a rapid rate. And most suppliers are offering systems with most of the components included.

System sizes are decreasing in favor of higher power systems. In effect we are changing from storing a large amount of energy that had to be discharged slowly to now storing a smaller amount of energy but being able to discharge it much more quickly.

Battery Safety has reached a point that it is now a secondary concern. Being far behind cycle life and power density.

Advancements In Technology



System sizes are decreasing due to better performance.

BELLONA



New ESS systems can be fully charged from 0 in as little as 15 min and fully discharged in even less time. Allowing huge power from a smaller and smaller systems.

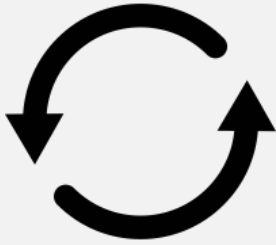
The System lifetimes are increasing, with some systems offering 4500 cycles at 100% Depth of Discharge and over 12000 at 80% Depth of Discharge, performance increases are the way of the future.

System costs are decreasing at a rapid rate. And most suppliers are offering systems with most of the components included.

System sizes are decreasing in favor of higher power systems. In effect we are changing from storing a large amount of energy that had to be discharged slowly to now storing a smaller amount of energy but being able to discharge it much more quickly.

Battery Safety has reached a point that it is now a secondary concern. Being far behind cycle life and power density.

Advancements In Technology



Over 15,000 cycles at 80%
Depth of Discharge.

BELLONA



New ESS systems can be fully charged from 0 in as little as 15 min and fully discharged in even less time. Allowing huge power from a smaller and smaller systems.

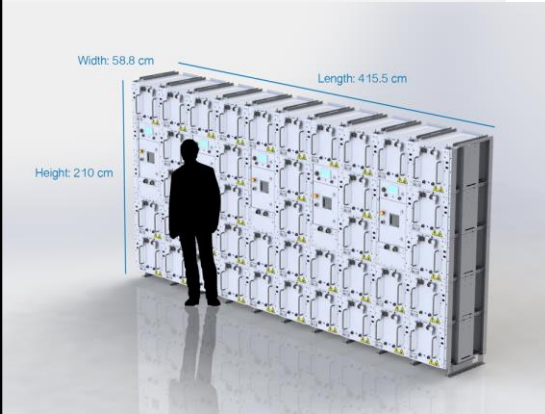
The System lifetimes are increasing, with some systems offering 4500 cycles at 100% Depth of Discharge and over 12000 at 80% Depth of Discharge, performance increases are the way of the future.

System costs are decreasing at a rapid rate. And most suppliers are offering systems with most of the components included.

System sizes are decreasing in favor of higher power systems. In effect we are changing from storing a large amount of energy that had to be discharged slowly to now storing a smaller amount of energy but being able to discharge it much more quickly.

Battery Safety has reached a point that it is now a secondary concern. Being far behind cycle life and power density.

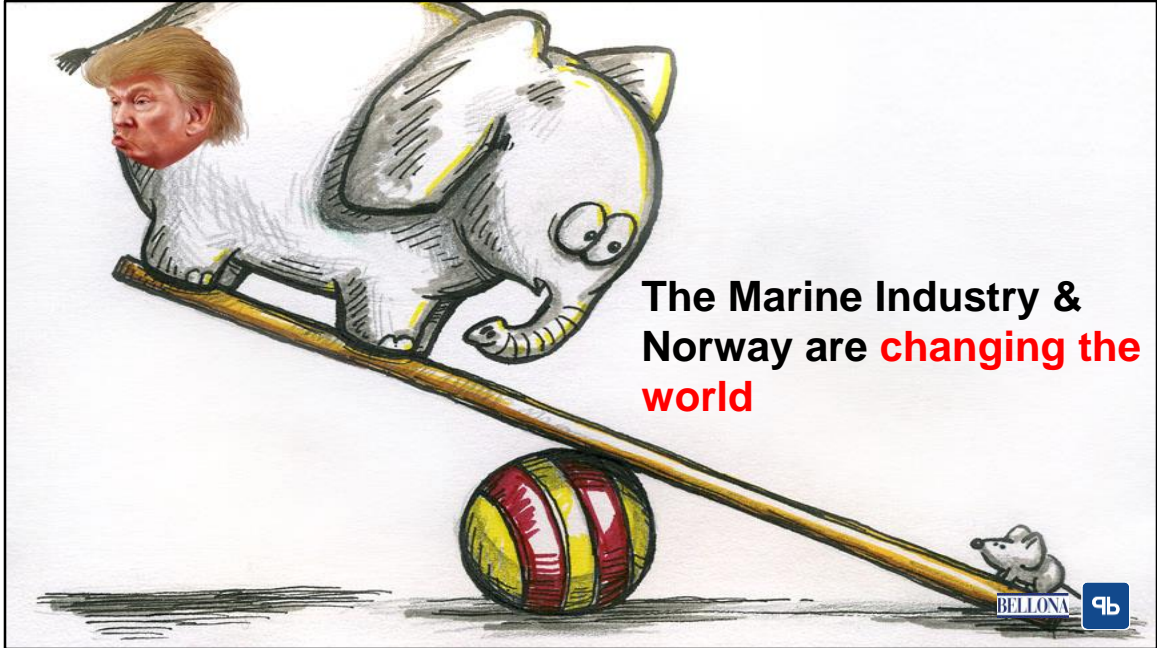
Energy Storage Facts



- New system lifetimes 44,000 to 88,000 hours standard
- Very low maintenance- save over 40% compared to conventional ships
- Built in fire & explosion safety
- With managed temperature internally, no external temperature limitations

BELLONA







PBES Norway- Your Energy Solutions Partner

Thank You