DP on Batteries

Lessons learned from Battery Hybrid Projects

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26 March 2018

Examples of sailing Battery Hybrid DP vessels in DNVGL class





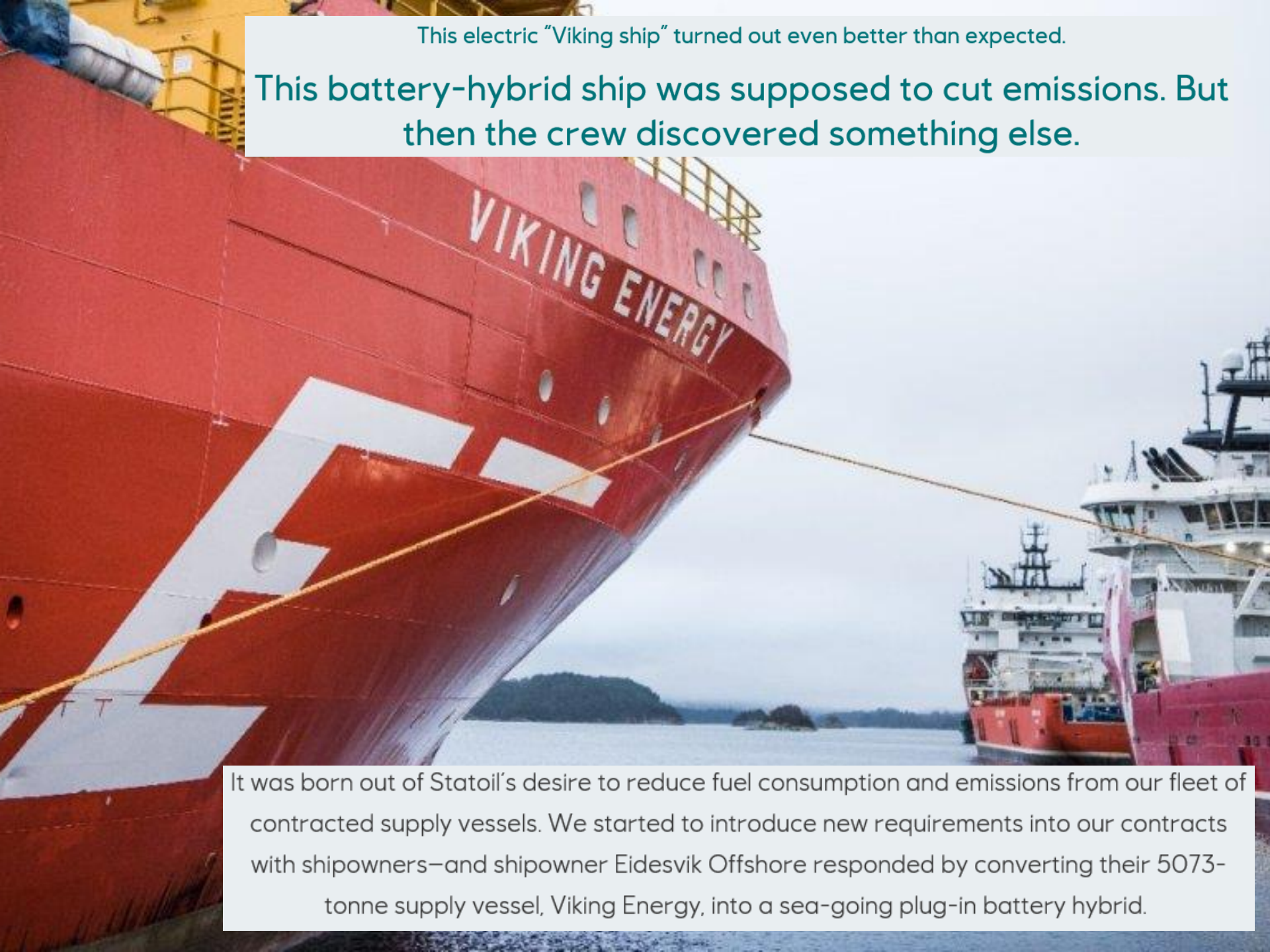










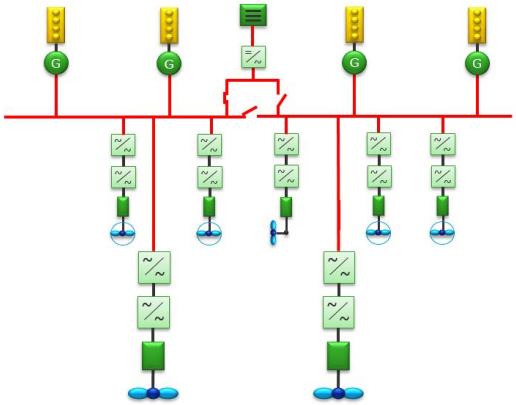



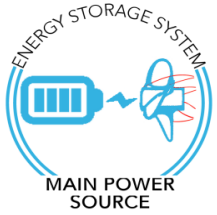
This electric "Viking ship" turned out even better than expected.

This battery-hybrid ship was supposed to cut emissions. But then the crew discovered something else.

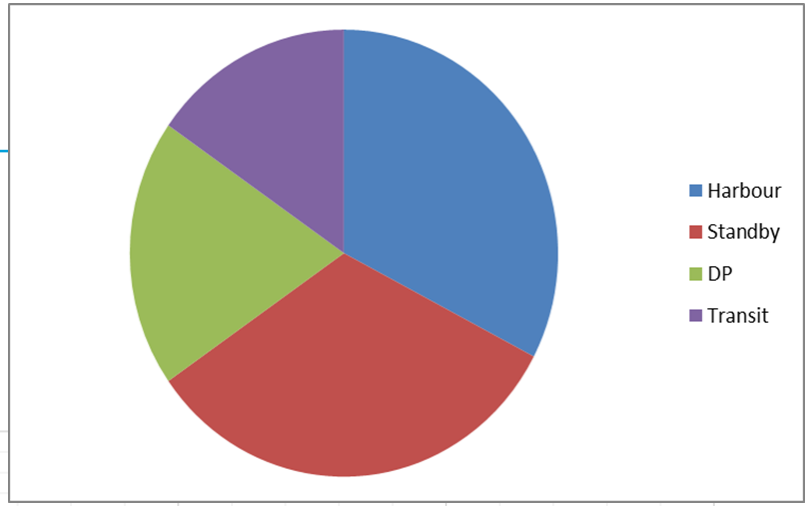
It was born out of Statoil's desire to reduce fuel consumption and emissions from our fleet of contracted supply vessels. We started to introduce new requirements into our contracts with shipowners—and shipowner Eidesvik Offshore responded by converting their 5073-tonne supply vessel, Viking Energy, into a sea-going plug-in battery hybrid.

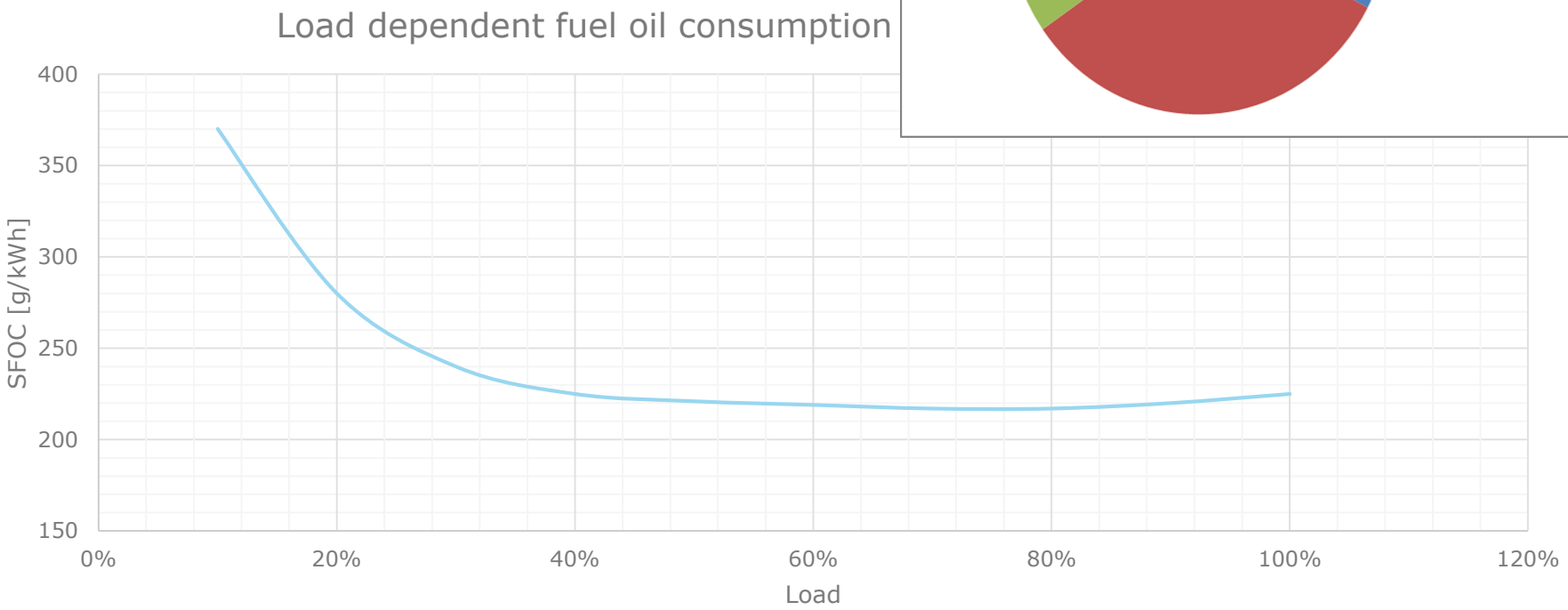
Batteries used as Energy Storage System (ESS)





Why batteries on DP vessels?





DP Design philosophy

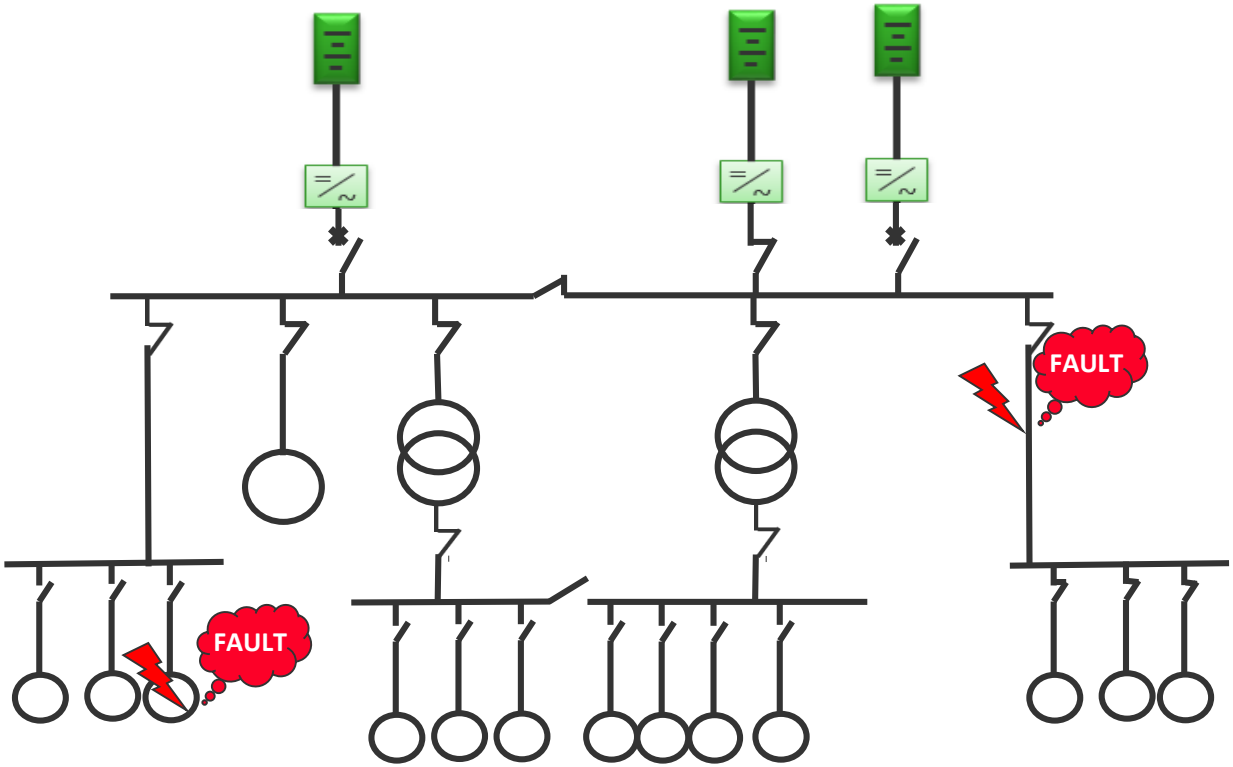
- The **DP philosophy document** shall describe the main features of the design and identify the redundancy design intent (including the separation design intent when required), as a minimum with respect to:
  - thrusters, propellers and rudders
  - engines and generators, energy storage
  - main switchboard arrangement
- The worst case failure design intent shall be stated
- The intended **minimum time requirement** shall be stated
- In addition the document shall specify the intended technical system configuration(s) during DP operation, as a minimum for the above listed components

The **minimum required time** duration for which the residual remaining capacity as defined by the worst case failure design intent shall be available. The time requirement will normally be governed by the **maximum time necessary to safely terminate the on-going operations** after the worst case single failure, given the residual remaining capacity. ... In addition to the actual time necessary to terminate the operation, the minimum time requirement **includes also the time necessary for detection and alarming by the system, and the time needed for the operator(s) to notice, make the appropriate decision(s), and initiate the termination process**.

Hybrid DP systems rule principles

- The rules apply when the energy in the battery(ies) shall be considered as part of the **redundancy for safe termination** (i.e. spinning reserve/running machinery)
- Then **Battery(Power)** notation shall be applied
- The philosophy is to consider a battery as a "***generator with a limited day-tank***"
- The energy in the battery must be closely **monitored**
- **Battery monitoring** is required at the **DP control station** (includes remaining time)
- The online energy level shall be provided to the DP control system so that this can be **incorporated in the online consequence analysis**
- **Uncertainties shall be accounted for by conservative time estimates**, (e.g in the accuracy of SoC (State of Charge) and SoH (State of Health)).

Fault discrimination



The FellowSHIP research project

FellowSHIP

FellowSHIP

WÄRTSILÄ

Eidesvik

DNV·GL

The Research Council of Norway

With funding from
The Research Council of Norway

Phase I 2003-2005

- **Fuel cell technology**
  - Feasibility study and conceptual design

Phase II 2006-2010

- **Fuel cell technology**
  - Onboard testing and measurements – Viking Lady

Phase III 2011-2014

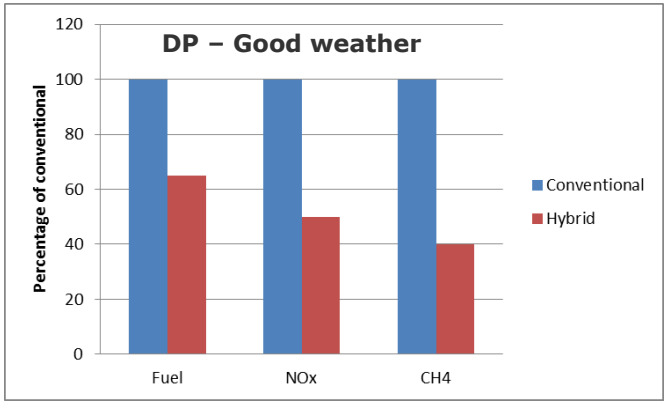
- **Li-Ion battery technology**
  - Development of hybrid design concepts
  - Onboard testing and measurements – Viking Lady

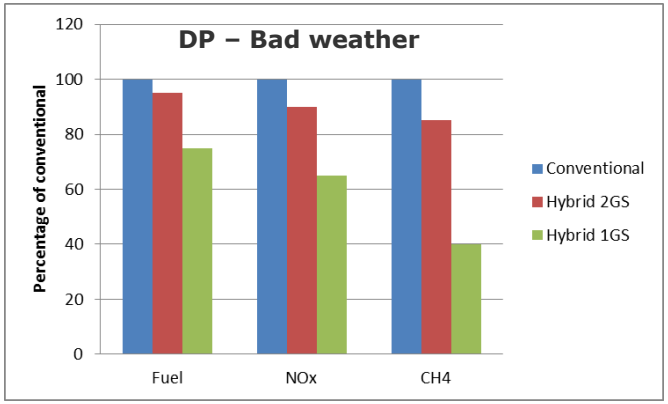
Phase IV 2015-2017

- **Li-Ion battery technology**
  - Performance optimization
  - Long term performance and lifetime

The FellowSHIP research project

- Fuel consumption can be reduced by 10-15%
- NO_X emissions by up to 25%
- CH_4 emissions by up to 30%
- Reduced maintenance costs
  - Less engine running hours
  - Less running on low loads
  - Longer intervals between planned maintenance
  - Less unplanned maintenance
- Improved machinery utilization/flexibility and vessel dynamic performance
  - Ramping time of engines no constraint





Experiences from the ship owner Eidesvik.

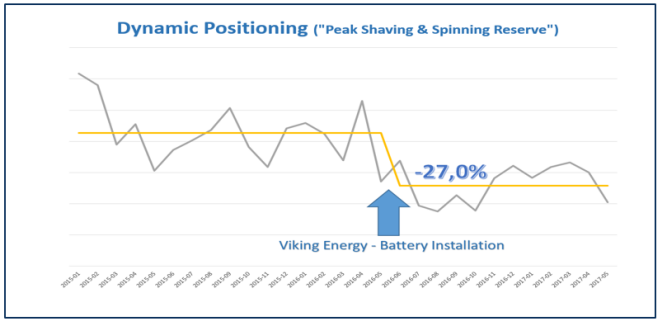
Viking Queen
- 652kWh – 1600kW
- Peak Shaving
- Load Levelling (Start-Stop)

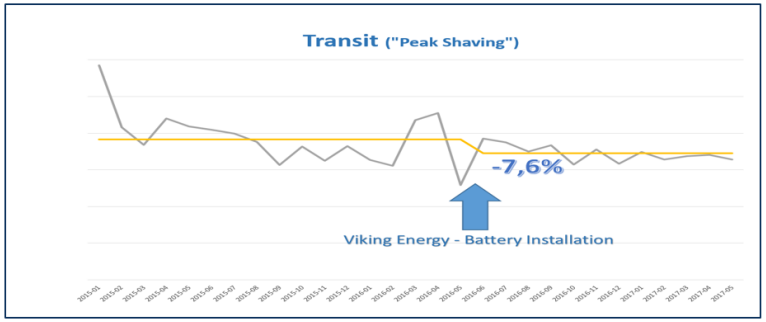
Viking Energy
- 652kWh – 1600kW
- Spinning Reserve
- Peak Shaving
- Load Levelling (Start-Stop)

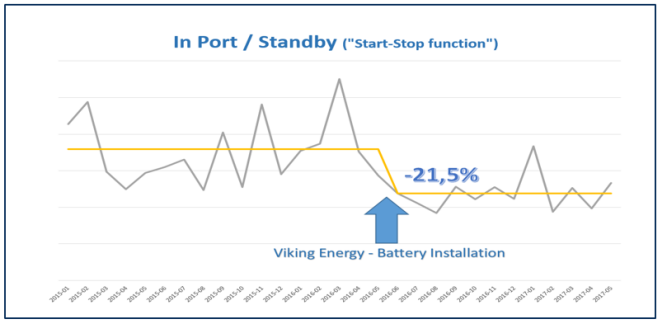
Viking Princess
- 511kWh – 1600kW
- Spinning Reserve
- Peak Shaving
- Load Levelling (Start-Stop)

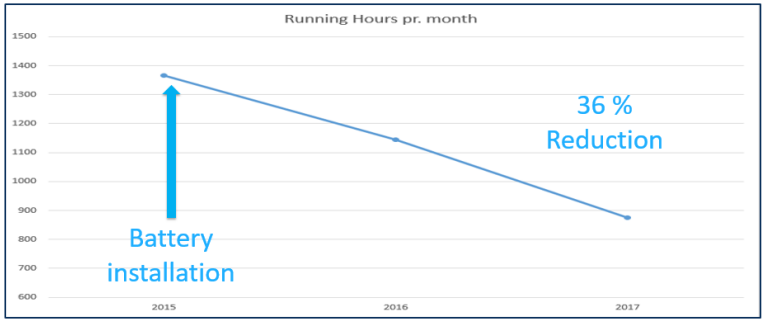
Experiences from the ship owner Eidesvik

Viking Energy –one year of operation









Experiences from the ship owner Eidesvik

Summary: Viking Queen / Viking Energy / Viking Princess

Viking Queen: Total **10-12% Fuel saving** (Peak Shaving & Start – Stop) - Not used in DP operations
Challenging startup, still challenges, now finally showing results

Viking Energy: Total approx **17% Fuel saving** (includes Battery Power – «Spinning Reserve»)
Didn't rush it, less challenges in operation, showing results immediately

Viking Princess: Total approx **15% Fuel saving** (includes Battery Power – «Spinning Reserve»)
Didn't rush it, some challenges in operation, showing results immediately, capacity will be increased due to lifetime calculations

Running Hours: reduced with **36%** on Viking Energy (assume close to the same also on Viking Princess)

No incidents due to Battery installations: Viking Energy Engine shutdown in Battery Power mode even «live tested»

Experiences from the ship owner Eidesvik

…so is it true what they say?

SAVING FUEL:	10% – **15%** – **30%** – 40%
EMISSION REDUCTION:	10% – **20%** – **30%** – **40%**
SAFER OPERATIONS:	No – Placebo – **Slightly** – Yes
REDUCED MAINTENEANCE:	No – **A little** – **A lot**
SYSTEM COST DECREASE ON ITS WAY:	No – **10%** – 25% – 50%
SIMPLE AND EASY INSTALLATION:	**No** – A few challenges – Yes
PAYBACK PERIOD:	**10 years** – **5 years** – **3 years** – 2 years

…AND STILL WELL WORTH DOING

DP on Batteries

www.dnvgl.com

SAFER, SMARTER, GREENER