Fostering Sustainability through Energy Storage Systems for Marine & Offshore Vessels

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Stig Settemsdal, CTO and Head of Portfolio Management & Innovation
Siemens Offshore Solutions
DC Power Grids Combined with Energy Storage Systems
Creating the Future Efficient Energy Mix for Coastal Transportation

Reduce fuel consumption with 100,000 tons
Reduce emissions of CO₂ with 300,000 tons
Green Solutions for Coastal Transportation

**Zero emission ferry “MF Ampere”**
- Capacity: 120 (in 20 min), 360 (in 20 min)
- Distance: 6 km, 6 km
- Fuel Cost savings: 60%

**“Elfrida” for fish farming**
- Distance: 12 km (in 50 min)

**Two ferries for Fosen Namsos**
- Capacity: 130, 390
- Distance: 8 km (in 25 min)

**Fishing boat “Karoline”**
- Diesel consumption: 0.04 l per kilogram of fish*

*measured by the first 30 operating days

**Ferry for FinFerries**
- Capacity: 90, 372
- Distance: 1.6 km

**Two ferries for Fjord1**
- Capacity: 120, 349
- Distance: 2.4 km

Operation dates:
- “MF Ampere”: Operation since March 2015
- “Elfrida” and Fjord1: Operation from Feb 2017
- “Karoline”: Operation from Jan 2018
DC Power Grid with Energy Storage Solutions
Creating the Future Energy Mix for Offshore Vessels

23MW LV DC Power Grid with Integrated Battery Energy Storage System
Integration of the Future Efficient Energy Mix in Offshore Power Solutions

**Wind Turbine Integration**

**ESS Integration**
- Batteries
- Supercaps
- Flywheels
- Fuelcells
- Photovoltaic

**Power from Shore Integration**

**Gas Turbine Integration**
- Diesel / Gas Engine Integration

**DC Grids with Battery ESS**

**Subsea Power & Drives Integration**
**Power Solution – Typical Case Study**

Optimize the Power Plant Selection with the Right Energy Mix

<table>
<thead>
<tr>
<th></th>
<th>MV AC Solution</th>
<th>LV DC BlueDrive PlusC Solution</th>
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<tbody>
<tr>
<td><strong>Design</strong></td>
<td>6,6kV power plant with dual fuel turbine driven generators. 2 x STG300 + 1 x Aux Diesel Generator</td>
<td>690V power generation with 4 x 4MW dual fuel diesel generators, main switchboard with integrated variable speed drives (BDPC).</td>
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<tr>
<td><strong>Installed power</strong></td>
<td>2 x 7,9MW = 15,8MW (ISO)</td>
<td>4 x 4MW = 16 MW</td>
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<tr>
<td><strong>Heat production</strong></td>
<td>2xWHRU</td>
<td>4xWHRU with burner</td>
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<tr>
<td><strong>Required footprint in process area</strong></td>
<td>~ 120m²</td>
<td>0 m²</td>
</tr>
<tr>
<td><strong>Weight power generators</strong></td>
<td>~ 180 ton</td>
<td>~ 360 ton</td>
</tr>
<tr>
<td><strong>△ Price</strong></td>
<td>~ + 2,5Mill EUR</td>
<td>0</td>
</tr>
<tr>
<td><strong>Availability/maintainability</strong></td>
<td>2 x 50%</td>
<td>4 x 33%</td>
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<tr>
<td><strong>Fuel consumption</strong></td>
<td>![Fuel consumption icon]</td>
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<td><strong>Environmental footprint</strong></td>
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<tr>
<td><strong>OPEX/Maintenance cost</strong></td>
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Energy Storage System
An Important Building Block in an Optimized Future Energy Mix

Offerings for our valued customers:

**Safety Power Back-up**
Power to maintain position and operation until power is restored, or safely terminate operation in case of long time power loss

**Peak Shaving**
Absorbs load peaks and load fluctuations to reduce the required available power from prime movers

**Performance Boost**
Instant power to absorb sudden load changes which reduce ramp time exposed by running engines. Allowing dynamic performance beyond that of typical prime movers

**Savings OPEX & CAPEX**
Improving fuel efficiency while also reducing running hours and wear and tear of equipment, provides savings in maintenance, overhauls and downtime. Reduced fuel, emissions taxes. May reduce number or rating of engines and thrusters

**Improved Environmental Footprint**
Reduces fuel consumption and emissions
Energy Storage Solution
Safety with Safely Stored Energy

Safety
- Cell level Thermal Runaway propagation protection
  - No active cooling required
  - No exhaust fan required
- Cell level temp monitoring
- Short circuit proof design
- Meets Arc flash safety standards

Performance
- Extended lifetime for heavy duty application
- Discharge up to 5 CP / Charge up to 3 CP
- Purpose built power controllers
- Seamless integration into AC and DC power grids from same entity

Each module with Autonomous Control Section
- Individual monitoring temperatures
- Cell balancing in module
- Safe disconnection control

Connections and interfaces
- Ducted pressure relief
- Fully SOGO Digitalization compliant
- Wireless connection from module to central control

Battery module 6,6kWh
- Nominal module voltage 100V DC
- Thermal runaway contained on module
- Gasses ducted to safe area
- 3D water cooled battery cells
- Plug in module design

Battery Pack 60kWh
- Nominal module voltage 900V DC
- Fuse protection of Battery pack

Battery System XX MWh (Your Choice)
- Designed like a LV switchboard
- Common DC Busbar
Digitalized Offshore Power Solutions
Asset Home page samples for power solutions
“link to live connection to an offshore vessel at this slide”

**Motors:**
- Trend: Current, Speed, Torque, Power,
- Histogram: Current, Temperature,+++ 
- Performance curves:
  - Winding temperature vs current +++

**VSDs:**
- Trend: Current, Speed, Torque, Power,
- Histogram: Current 
- Performance curve:
  - Heatsink temperature vs current ++++

**Transformers:**
- Trend: Current, Power, Temperature 
- Histogram: Current, Temperature,+++ 
- Performance curves:
  - Winding temperature vs current +++

**UPS incl batteries:**
- Trend: Current, Power, Temperature 
- Histogram: Energy, Charging Current, Temperature,+++ 
- Performance curves:
  - SOC, SOH +++
An Energy Storage System should be Digitalized from birth…

Performance Monitoring of CP «Charge Power» and «Discharge Power» Available (C-rate)

Monitor State of Charge

Monitor Water Temp vs. Cell Temp

Monitor Ambient Room Temp vs. Cell Temp

Monitor State of Health

Performance Monitoring of CP «Charge Power» and «Discharge Power» Available (C-rate)

Cell Temp Monitoring and Cell Voltage Balancing

Full Automated and Digitalized Battery Production Plant
Siemens Offshore Solutions Technology

Stig Olav Settemsdal
CTO and Head of Portfolio Management & Innovation
Siemens Offshore Solutions

Oestre Aker vei 88
0596 Oslo, Norway
Fax: +47 7395 9022
Mobile: +47 92651415
mailto:stig-olav.settemsdal@siemens.com
www.siemens.no
www.siemens.com/ingenuityforlife