Introduction

- Straum is a Norwegian-based technology developer and turnkey provider of offshore renewable power plant systems:
  - Hydra Tidal™ Tidal & Ocean Current Power Plants
  - OWC Power™ Wave Power Plants
  - WindSea™ Floating and Fixed Offshore Wind Power Plants

- Straum is a part of more than 150 years of history within developing and constructing offshore structures and hydro power plants.

- Straum is owned by Ard Group AS, also involved in hydro power technology and engineering and construction of offshore oil & gas modules.
Ard - Development & Brands

1946
Established

1999
Start – “Period of growth”
Turnover 120 MNOK
100 Employees

2005
NLI a turnkey provider

2007
Rainpower

2009
Sunkost

2011
Straum and Mustad
Turnover 2500 MNOK
1700 Employees

Verdijustert EK
Omsetning
Straum Technology portfolio

- Offshore Wind Floater
- Offshore Wind Jacket
- Tidal & Current
- Wave Power
Competiveness

- All technologies “in-front” & backed by strong IP portfolios
- In house high-end competence within system design & project execution
- Industrial alliance with strong players like Rainpower & NLI
- “Tech-Vendor” Business model based on “local” alliance
- Units capable to deliver power at very competitive cost-levels
Hydra Tidal™
The Floating Tidal & ocean current Energy Solution
The Morild Technology

- The prototype has an installed effect of 1.5 MW (4 turbines)
- Total weight 410 tons
- Theoretical annual energy production 5.0 GWh
- Turbine diameter of 23 meters (each turbine is pitch controllable)
- The MORILD II can be anchored at different depths, and may be positioned in spots with ideal tidal stream conditions
- The plant carries a sea vessel verification, and is both towable and dock-able
- The floating installation enables maintenance in surface position and on site
- The plant can easily be moved, towed and taken into dock
- The MORILD II will be remotely operated, and has an on-shore surveillance system
Wave Power

- Based on technology developed and tested in the 80ties
- Principle: Oscillating Water Column
- 500kW Wells turbine – driven by air
- Structural Design: To create resonance to optimize energy output
- Ongoing model testing to verify the design. Then heading for the market
- Market: Existing near shore infrastructures
The OWC Technology™

Point Absorber

Aboorption of wave energy based on the principle of point absorption – high energy density

Oscillating Water Colum

The waves moves into a controlled and sealed chamber whereas the its converted to air waves

Wells air turbine

The compact high speed turbine, driven by air waves, connect to a standard generator.
Prototype test-site at Toftestallen, built in the 1980`s by Kvaerner

A prototype built in the 1980`s at the western coast of Norway.

Stop in further development due to:
- Technical challenges
- Lack of funding and
- Too early for the market.
The OWC – R&D – Wave flume (the OWC)

The flume:

5*60 m wave flume
Hydraulic wave machine
13 wave sensors
2 pressure sensors

Purpose made analysis program in LABView

Tests started last year and are going on today.
The OWC – R&D – Turbine

$\frac{1}{4}$ scale
4000 RPM, 60 kW

Wells turbine – assembly of the hub and runner blades.

Wells turbine – runner blade

Wells turbine – illustration
The OWC – R&D – Turbine

Test rig assembly. Final installation of the Wells turbine and its generator.

Process diagram of test rig

Power control unit for the fan generating air for the Wells turbine + power control for regeneration of power generated by the Wells turbine.

Test cabin with all instrumentation and data logging system. Operator EHS initiative, mechanical and noise protection during testing.
OWC Power™ - Concept advantages

- Compact turbine system
- Few moving parts
- Adaptable to both offshore and shoreline installations
- Ideal for breakwater installations
- Easy maintenance due to compact system
- Low cost installation
WindSea Floater™
The Floating Offshore Wind Power Plant
WindSea Floater™ - Key Features

The WindSea floater

Key technical features*

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbines:</td>
<td>3 x 3.6MW (3 x 5MW ++)</td>
</tr>
<tr>
<td>Rotor diameter:</td>
<td>104 m</td>
</tr>
<tr>
<td>Colum distance:</td>
<td>75 m</td>
</tr>
<tr>
<td>Height two front towers:</td>
<td>71 m (above sea)</td>
</tr>
<tr>
<td>Height rear tower:</td>
<td>90 m</td>
</tr>
<tr>
<td>Weight (ex turbines):</td>
<td>3,780t</td>
</tr>
<tr>
<td>Min water depth:</td>
<td>Approx. 45m</td>
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<tr>
<td>Max water depth:</td>
<td>No limitation</td>
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</tbody>
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*Based on a 3 x 3.6MW design

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Pre-installation of the anchor and mooring system as well as the power export cable.

Easy pull-in of the mooring system through a Turret at the platform during installation.
WindSea Floater™ - Favourable total energy production

**Significant test results**

- Total energy production of 3 stand alone 3.6MW turbines is 44.5 GWh/year
- Total energy production for the WindSea floater with 3 x 3.6MW turbines verified to be 41.4 GWh/year*
  - The wake-effect only influences the rear turbine energy production (see dark blue line in the graph to the right)
- Testing has been done by using specific field data, a specific turbine type and assumed availability of 85%

93% of maximal production of 3 stand alone turbines achieved

*Based on Ekofisk field wind data and 3 x 3.6MW turbines
**Energy production for stand alone turbine, equal to the production of one of WindSea’s front turbines

Source: Risø and WindSea

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