International OTEC Symposium
Kuala Lumpur - Malaysia sept 2015
OTEC by DCNS: Latest and future developments

DCNS – Energy Direction
Thierry BOUCHET, Head of OTEC technology development
Our first OTEC plant in La Martinique is called NEMO

Our priority, in accordance with the NEMO program financial calendar and performance requirements is to finalize the NEMO plant definition using proven solutions to achieve an optimum energy production in terms of performance and availability

We are completing the cold sea water pipe development through conduction of tests and industrialization

Lowering the cost of energy is a priority even for the first plant
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The NEMO schedule

- End of design – 2016
- Installation – 2019
- Commissioning and full Operation - Summer 2020 in accordance with the European Commission NER300 program
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NEMO key performances

- Offshore plant, 5 km off the coast
- Average depth 1300 m
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NEMO key performances

• Average of more than 10 MWe over the year on Martinique grid depending on sea conditions with a maximum installed capacity of 16MWe
  • Δt annual average of 24 °C
  • 0.1°C variation (Δt) => one variation ≈ 110 kWe on the net power
  • 1 mbar variation in pressure losses on sea water pipes => - 1 kW/module on net power
  • Ratio net power/gross power ≈ 65 %

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NEMO key performances

- Availability of more than 90%
- Operational in annual cyclonic conditions
  - Swell up to 2 m
- Withstanding centennial cyclonic conditions
  - Swell up to 7 m
- Life time of 25 years
- Operated from the coast
- COE ≈ 450 €/MWh

Swell map in cyclonic conditions
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NEMO specifications

- **Anchored platform**
  - Barge integrating the cold sea water pipes deployment system (length ≈ 85 m, width ≈ 30m, height ≈ 20m)
  - Mooring system: semi-tensioned steel cables, conventional anchors

- **Cold sea water riser**
  - A giant flexible suction sea water pipe, with a diameter ≈ 5 meters
  - Two flexible or semi-rigid discharge sea water cold pipes with a length ≈ 100 meters

Drawing at scale

Slope 17%
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NEMO specifications

- Energy system
  - 4 modules
  - Simple Rankine ammonia cycle (≈ 200 tons)
  - Shell and titanium tubes heat exchangers
  - Not submerged centrifugal chopper seawater pumps with low speed (for cold and hot sea water)
  - Warm sea water filters with flush air
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Determination of the adopted technical solutions performance using both numerical simulations and representative trials

- Continued testing on the La Reunion’s onshore test bench with a reduce-scale heat exchanger

- Study and realization of a specific test bench to qualify microfouling reduction systems (preventive and corrective), installation in La Martinique in 2016 with IFREMER, our main partner
  - Preventive actions (electrochlorination, ozonation, …)
  - Corrective actions (brushes, pressurized spray, …)
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Determination of the adopted technical solutions performance using both numerical simulations and representative trials

- **Cold sea water riser**: Continued trials in air and water (pools and open sea) with components at full and reduced scale with IFREMER. Study and realization of the test benches. Developing the sea water pipes requires important financial investments.

- **Industrial production of the cold sea water riser**
  - We are currently producing components at scale 1:1.
Energy production is dependent on both the instantaneous performance and the ability to maintain this performance over the life of the plant.

Our actions are therefore also focused on the selection of the equipment and their maintainability and their accessibility.

Thanks to our long experience with operational maintenance of military ships, we are confident that we are making the best decisions for our future OTEC plants.
**OTEC by DCNS: Developments tomorrow**

DCNS also plans future steps

- **Performance improvement**

  - **Work on new heat exchangers**

    - Plate Heat exchangers and straight aluminum channels: DCNS has been working four years with a manufacturer to qualify materials to resist sea water
    - For heat plates exchangers so-called tubes we are less active on this subject for the moment, priority is given to heat plates aluminum exchangers
    - These two families of exchangers will be tested on the La Reunion onshore test bench, starting 2016 I think some of you have already visited our test bench
    - Tests on different kind of tubes with ERIE (Engineering Research Innovation for Energy) a French company
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DCNS also plans future steps

• Continued work on biofouling reduction, tests in different seas after initial test in La Martinique
• Extension of our cold sea water pipe concept for higher flow and harsher sea conditions

• Lower costs
  • qualification of more cost-friendly materials and technologies.
  • consolidation of the industrial sector.
OTEC by DCNS: Developments today and tomorrow

Terima kasih kerana memberi perhatian

Thank you for your attention