



Floating offshore wind



Tidal turbines



Wave energy



Ocean thermal energy conversion

DCNS sea THE FUTURE

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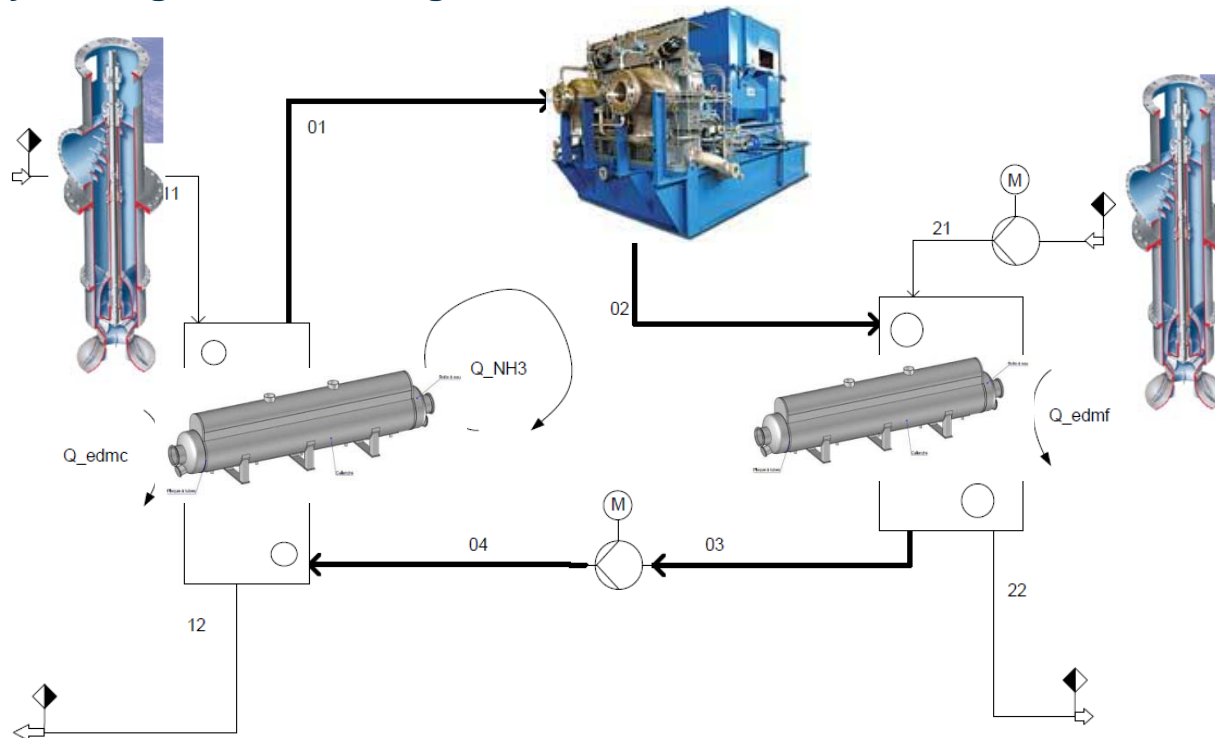
OTEC TECHNOLOGICAL STRATEGY DEVELOPMENT FOR DCNS

Simplicity is the ultimate sophistication (Leonardo da Vinci)

- For a given resource temperature and cost (CAPEX + OPEX), the goal is to maximize energy production in order to reduce the COE (Cost Of Energy), which is the key element in making OTEC a turnkey industrial reality.
- Energy production depends on both instantaneous performance and the ability to maintain this performance through the lifetime of the power plant, at a high availability - around 90% .
- Inside DCNS, the 30 member OTEC team strives to achieve the performance of a marathon runner more so than that a sprinter. As such, the technical objective is to reach a consistently high performance based on mature technical solutions with proven track records of performance and maintainability.

OTEC TECHNOLOGICAL STRATEGY DEVELOPMENT FOR DCNS

- The DCNS R&D OTEC program is moving towards proposing a turnkey reliable system :
 - Simple Rankine Cycle ammonia
 - Shell and titanium tubes heat exchangers
 - Turbo expander ammonia with asynchronous generator
 - Not submerged centrifugal chopper seawater pumps with low speed (about 300 rpm)
 - Efficient system against biofouling



OTEC TECHNOLOGICAL STRATEGY DEVELOPMENT FOR DCNS

- DCNS determined the performance of the adopted technical solutions using both numerical simulations and representative trials.



- From their adopted solutions, DCNS performs technological developments in the short, medium and long term to provide the best technical and economical response for onshore and offshore the OTEC plant.



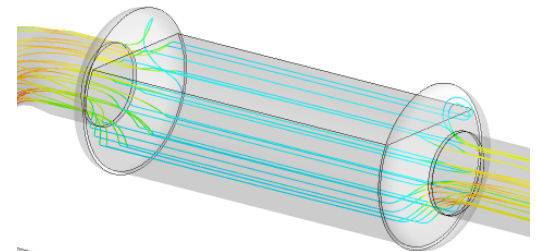
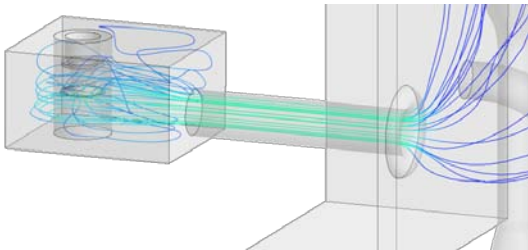
Offshore plant from 10 to 30MW+



Onshore plant up to 10MW

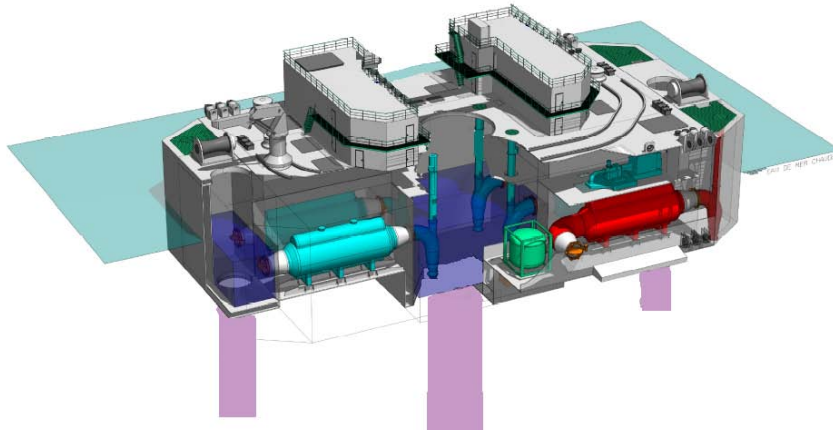
OTEC TECHNOLOGICAL STRATEGY DEVELOPMENT FOR DCNS

- To ensure a high overall availability:
 - Each device has itself a high availability
 - Redundancies are made where possible, for example NH3 pumps, operating system, ...
 - The capacity of the plant is adjusted by adding modules with an output of ~ 5 MWe installed. The loss of a non-redundant equipment results only in the the loss of a single module
 - Each equipment is maintainable, including the deep sea water conduct.
- Lifetime reliable/steady performance depends also on the ability to optimize the net power / gross power ratio. This implies a minimization of power consumption by
 - Decreasing pressure losses in sea water circuits
 - Achieving high performance with seawater pumps



OTEC TECHNOLOGICAL STRATEGY DEVELOPMENT FOR DCNS

- The reduction of pressure losses involves:
 - On the platform, seawater pipes with large diameters and few singularities
 - Out from the platform, large diameter for cold seawater suction pipes (about 4000 mm diameter for 100 000 m³ / h)

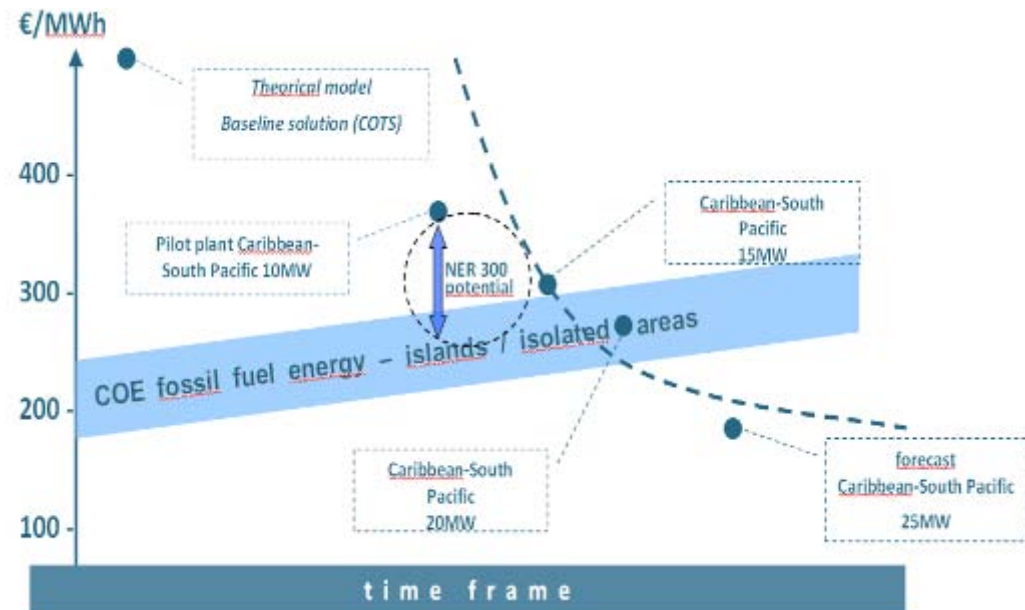


- One has to learn how to destroy in order to create.
Regarding the cold sea water pipe, we have developed a totally innovative proprietary concept of giant flexible pipe:
 - Installed from within the platform,
 - Very large section,
 - Can be maintained,
 - Can be put in a safety position if cyclonal situation arises
 - Does not impose specific conditions of stability to the platform

OTEC TECHNOLOGICAL STRATEGY DEVELOPMENT FOR DCNS

DCNS on the right tracks to mitigate risks and monitor all key success factors & meet customers' demand on :

- Competitive Cost Of Energy
 - 250€/MWh target
- Risk management / risk mitigation
 - Bankability of projects
- Technological readiness
 - Patents on all critical sub-equipments
 - Reference plant designed
 - Technological optimization process in place
- Tailor made industrial competitiveness
 - Dedicated industrial organization
 - Including local content
- Acceptability of projects
 - Both social and environmental positive acceptability
- Partners bankability
- Strong support from both local and national authorities



DCNS

sea **THE FUTURE**®

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