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R & D



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**EDF R&D activity in the field of
marine current energy**

**EDF acteur du développement
hydrolien**

Cyrille Abonnel
Project Manager

Clément Buvat
Research Engineer

R & D

EDF an active-player in the development of marine current energy

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EDF, Electricity producer

- › Power generation assets where nuclear and hydroelectricity are well represented,
- › A wish to diversify the sources of energy (« bouquet énergétique »).

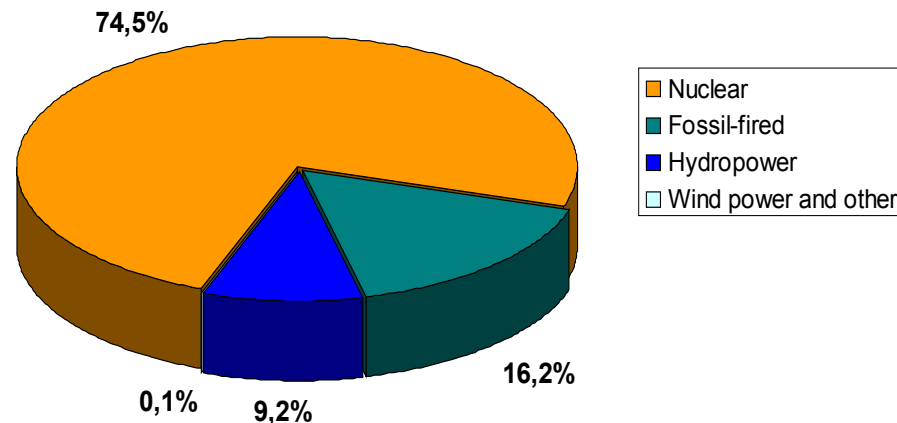
EDF is active in the development of marine current energy with :

- › A Research and Development project aimed at an experimental site,
- › Partnerships at a European level.

La Rance plant, France



EDF Group Worldwide Power Generation (2003)



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Vision of an industrial producer

- › An advantage of the current turbine energy
 - *the predictable and quasi-steady nature of tidal currents.*
- › In Europe, marine current energy converters
 - *Would not be considered as decentralized energy,*
 - *Would be designed to be coupled to the electrical grid.*
- › A production which should be reliable and cost-effective
 - *Commercial “farms” (some tens or hundreds MW installed),*
 - *Multi-hundreds kW converters.*
- › An energy to join and “learn from” the other energies
 - *Complementary to classical and renewable energies,*
 - *To learn from the industrial development of wind energy*

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Key-points for the global development of this energy

- › Development of industrial turbines
 - *Several on-going developments in Europe*
 - *EDF, as a producer, not directly involved in any device development*
- › Integration of turbines in the environment ?
 - *Independent Environmental Impact Assessments*
 - *Consultations to screen their acceptability*

Unknowns for the development of this energy in France

- › How to fund the “gap” between R&D studies and industrial projects take off ?
 - *Market mechanisms as in other European countries ?*
 - *In France, a micro-hydro tariff exists, but is it enough ?*
- › Administrative and legal aspects of their integration
 - *To be treated with the Administration services*

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The EDF R&D Tidal Project (projet “Hydroliennes en mer”)

Objective : to gather by 2006 the techno-economic elements to decide whether we take part in an industrial demonstration site within the French waters.

- › Watching the technological on-going developments
- › Exploring the environmental impact and acceptability issues
- › Exploring the economic and administrative issues
- › Improving the resource knowledge in the French waters
 - *Matching various criteria to identify the “tidal zones”*
 - *Measuring and modelling the hydrodynamics*

⇒ *Focus on this “hydrodynamic” research axes afterwards*

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Some “hydrodynamic” research axes :

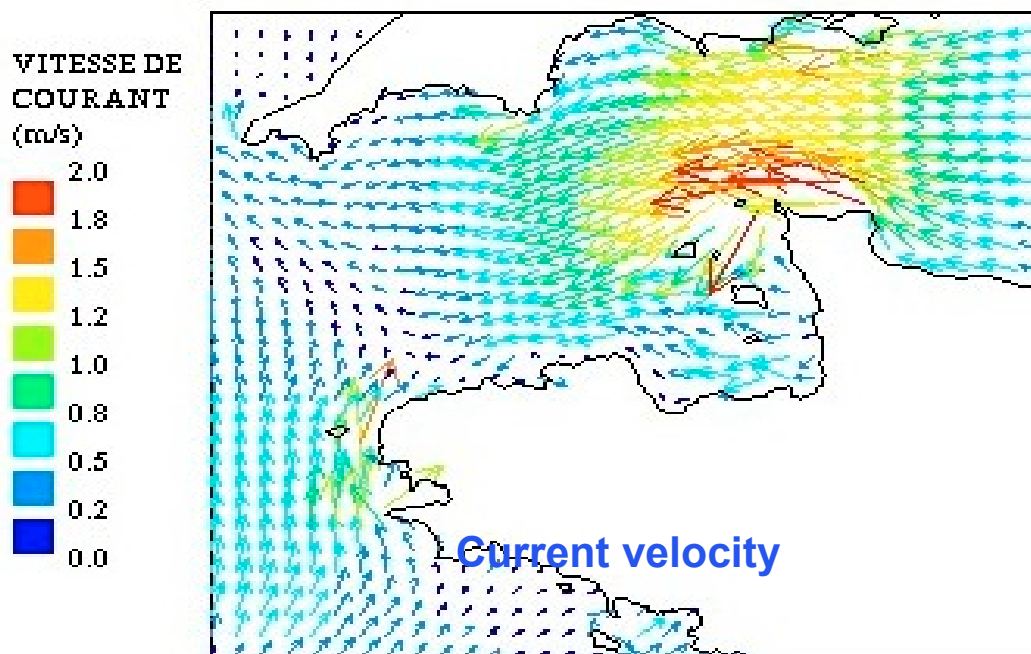
- › Numerical model for current prediction has been applied to define suitable locations according to :
 - *Current potential,*
 - *Water depth,*
 - *Wave conditions,*
 - *Distance to coast,*
 - *Special areas (nature reserve, fishing areas, ...) ...*
- › Measurements on site to confirm numerical simulations.

- › Some studies focus on the phenomenon which can induce a variation of generated power like :
 - *Wake effect for farm spacing optimisation*
 - *Wave influence on the turbines*
- › Indeed, better knowledge on the ratio « producible power on installed capacity » and the annual energy yield is required.

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The “hydrodynamic” research axes : Current prediction for suitable sites for current marine energy conversion

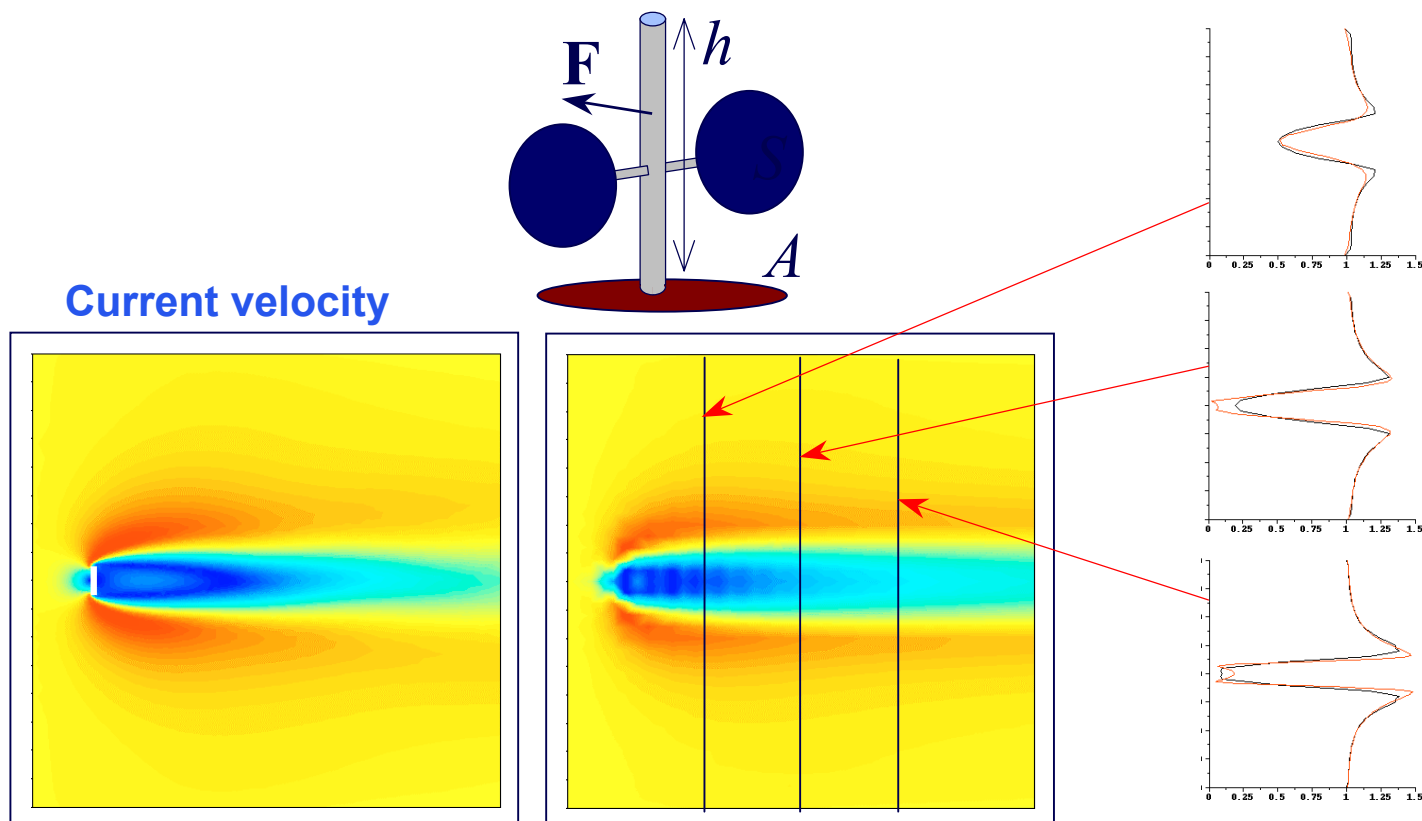
⇒ Numerical study with TELEMAC 2D (Hydrodynamic Finite Element Package) along the French coasts.



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The research axes : Wake effect for marine current farms (1/2)

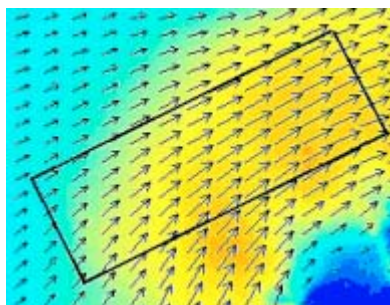
- › Modification of the Current velocity due to one turbine ...



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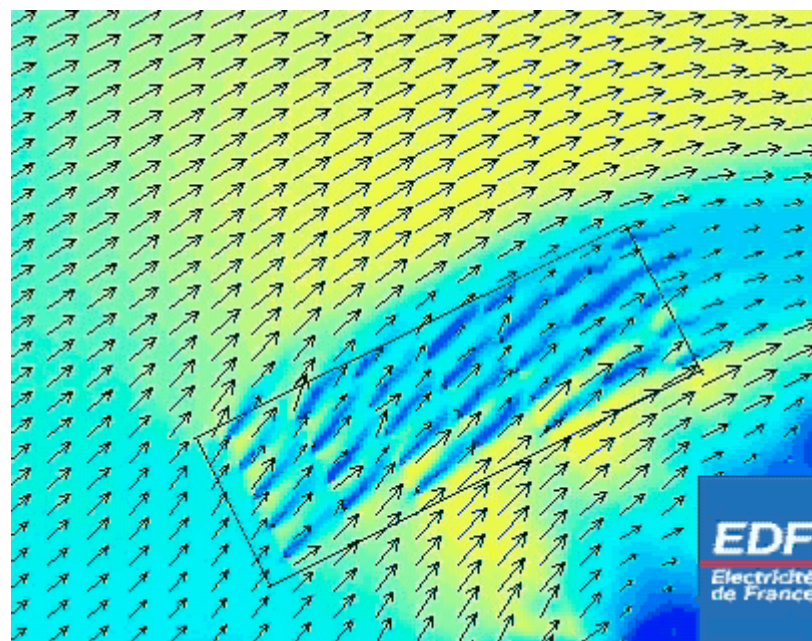
The research axes : Wake effect for marine current farms (2/2)

- › Modification of the Current velocity due to one turbine ... applied to a farm



Tidal currents alone

Tidal currents +
converters



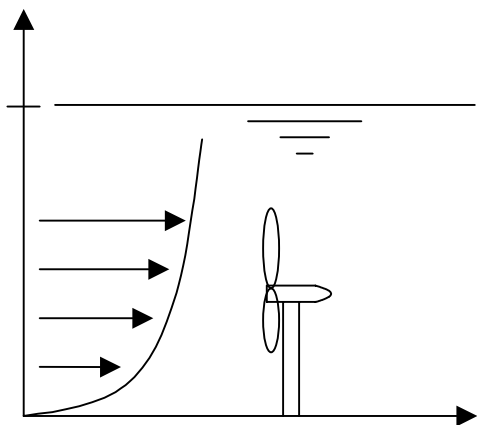
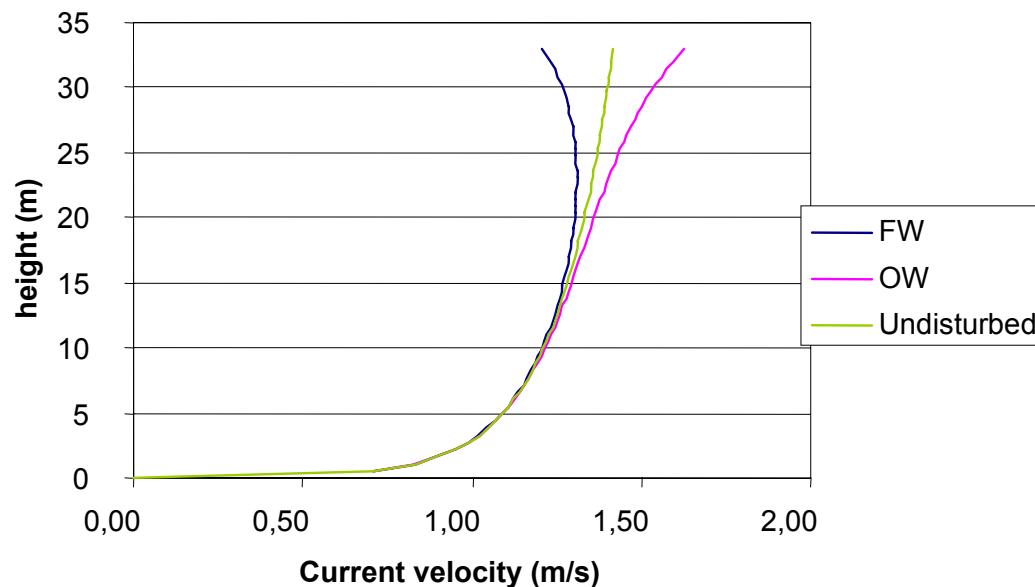
⇒ Optimisation of the farm spacing

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The research axes : Wave effect

Study on wave influence on rotor power output :

- › in the following
- › or the opposite direction of the current



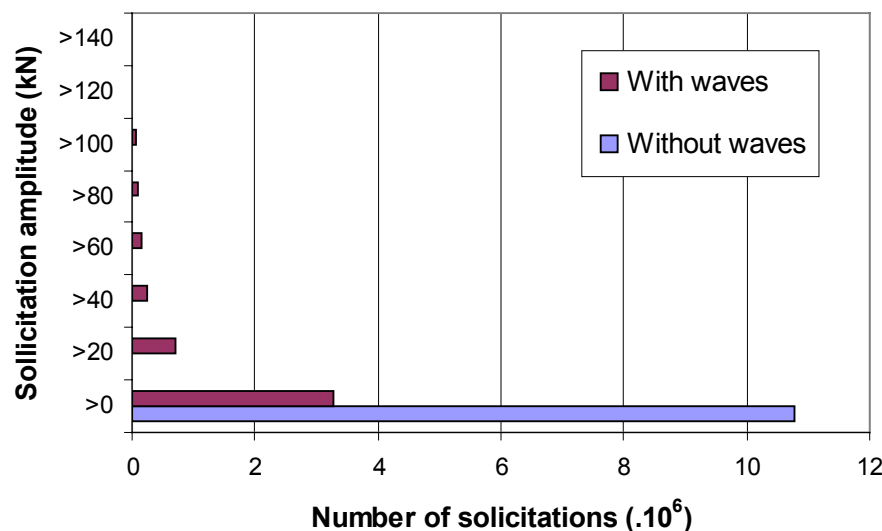
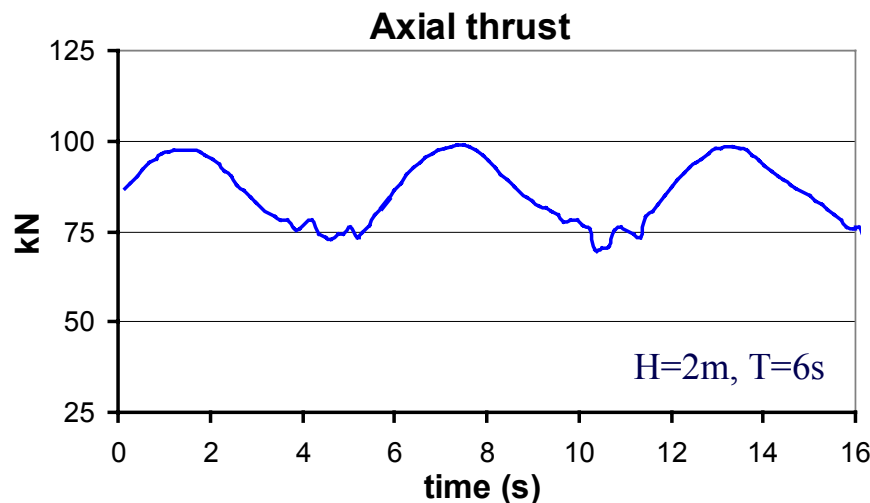
	Energy Yield
Without Wave	100 %
With Following Waves	~ 90 %
With Opposite Waves	~110 %

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The research axes : Wave effect

Study on wave and current loads on the structure :

- › Oscillatory motion
 - ⇒ variation in angle of attack on the blades
 - ⇒ large oscillation
 - ⇒ fatigue (structure and drive train)



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Conclusions

- › EDF, with a wish to diversify the sources of energy, is involved in the development of marine current energy through an R&D project and European partnerships,
- › In this R&D project, some studies focus on improving the resource knowledge in the French waters at various scales,
- › The aim of the project consist in developing an experimental site ...
- › ... and preparing the industrial development of commercial farms.
- › Some key-points (administrative, legal aspects...) and unknowns (tariff...) have to be clarified.



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