



ADVANCED TECHNOLOGIES FOR RENEWABLES

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OFFSHORE WIND

TEESIDE – 27 SETS OF 2,3 MW TURBINES – 100% EDF GROUP SHARE – GRID CONNECTED IN 2014



OFFSHORE WIND : A MOVE TO HIGHER POWER TURBINES



Test of Halliade 6 MW turbine onshore

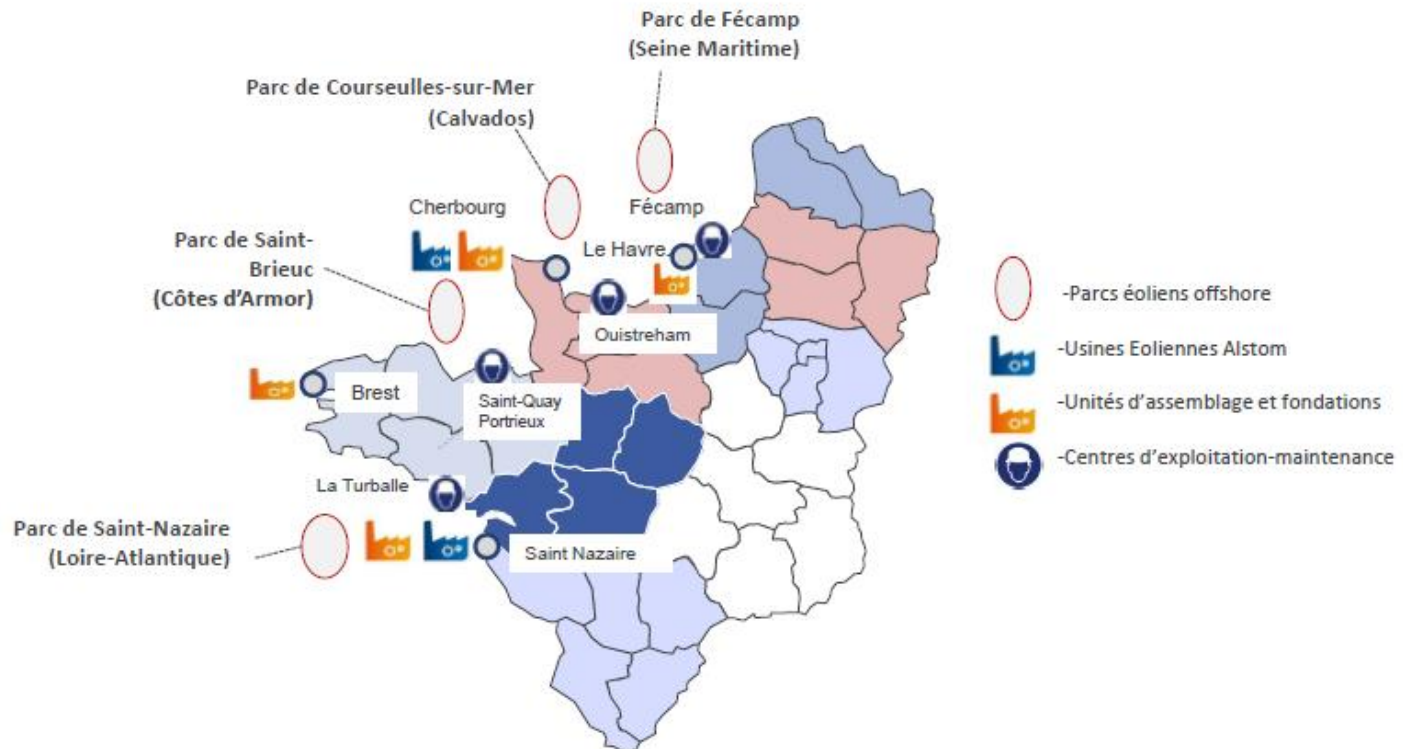


Installation of Halliade 6 MW turbine offshore, grid connected now

INDUSTRIAL PLAN FOR OFFSHORE



RETOMBÉES POUR LES PORTS EN SYNTHÈSE...



FLOATING WIND OFFSHORE USING VERTICAL AXIS TURBINE

- Usefull for high depth zones like Mediteranean sea,
- Advantage on Operation and construction : possibility to bring/bring back the turbine fully mounted,
- Market potential is higher than fixed offshore turbine
- For floating offshore, vertical axis turbine is superior, also more innovative/risky



Floating Offshore : Nenuphar/AREVA partnership with EDF EN



Technology Provider : Nenuphar

Turbine provided by AREVA
Technology provider for floater
still to be determined (RFI
underway)

Owner : EDF EN



STORAGE TECHNOLOGY USING NaCl_2 BATTERIES

TEST IN COLOMBIERS : ZEBRA BATTERY + CONTROL AND COMMAND ON THE BASIS OF A 57 KW PV/30 KW BATTERY PLANT

Scale 1/100^{ème}

3 Batteries + 57kWc PV

Automate PPC

Energy management System provided by Store & Forecast

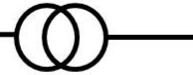
Prévision, optimization, regulation



PV : Toucan 5MWc / Test zone 57 kWc



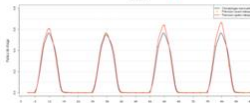
PV inverters



Power Plant Controller



Energy Management System



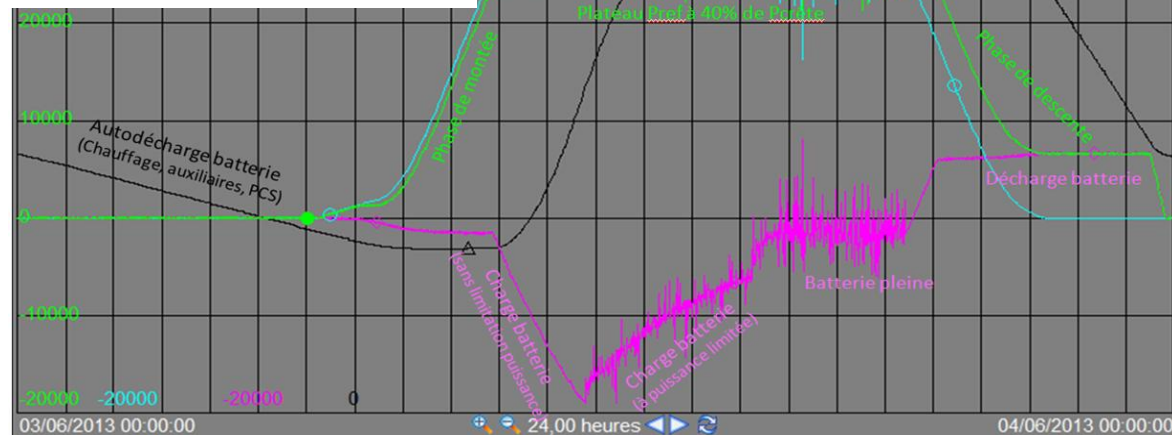
Meteo forecasts



Batteries : 1,6MW x 3h / 18 kW x 3h



AC/DC inverter & DC/DC chopper



Qualification et performances batterie

Développement contrôle commande

Performances PMS

Performance énergétique globale

Optimisation phase réalisation

Approche O&M

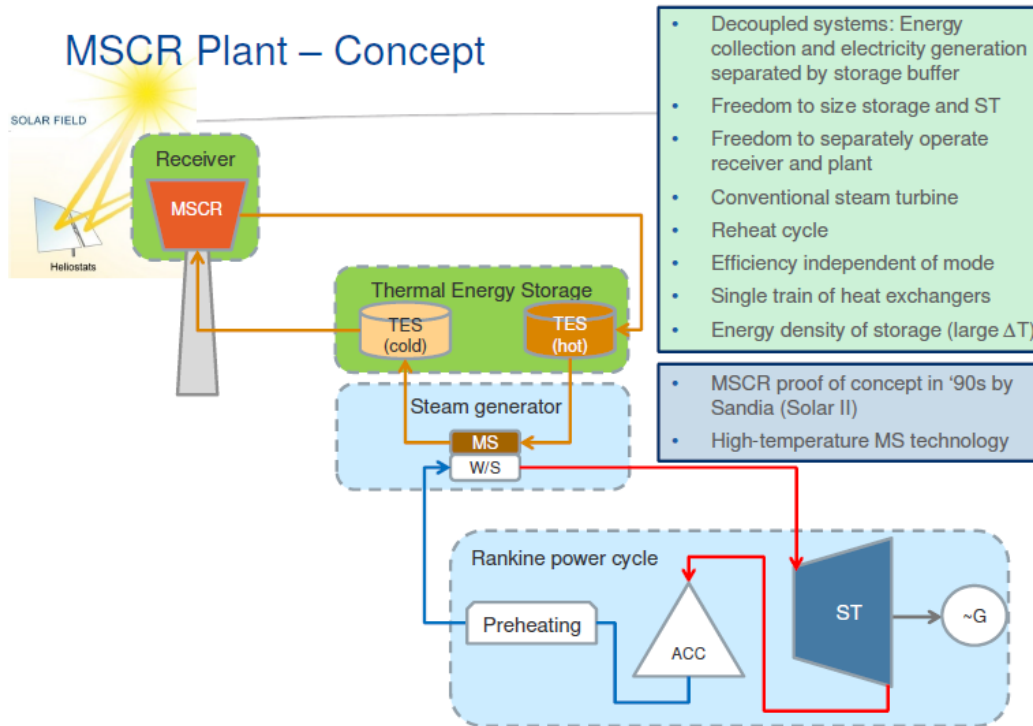


CONCENTRATED SOLAR POWER

EDF EN CSP PROJECT IN MOROCCO

NEW TECHNOLOGY (ALSTOM): MOLTEN SALT POWER PLANT

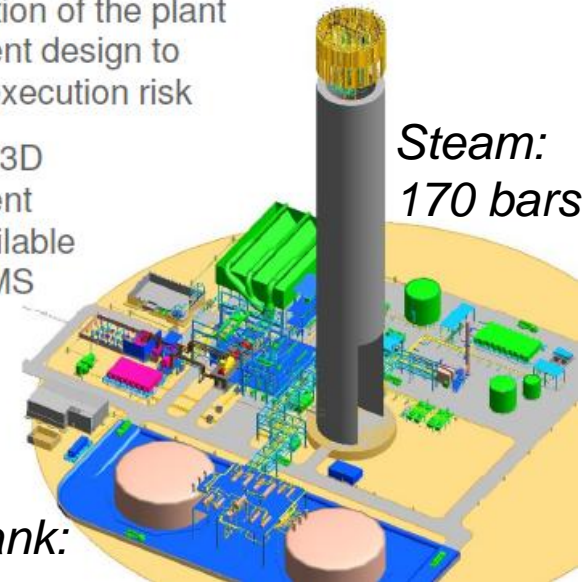
MSCR Plant – Concept



- Decoupled systems: Energy collection and electricity generation separated by storage buffer
 - Freedom to size storage and ST
 - Freedom to separately operate receiver and plant
 - Conventional steam turbine
 - Reheat cycle
 - Efficiency independent of mode
 - Single train of heat exchangers
 - Energy density of storage (large ΔT)
- MSCR proof of concept in '90s by Sandia (Solar II)
 - High-temperature MS technology

Plant layout - 3D model

- Full validation of the plant arrangement design to minimize execution risk
- Advanced 3D arrangement model available from DS+MS



Steam:
170 bars

Cold tank:
290°C

Hot tank: 565°C

Main interests → lower LCOE than direct steam, long term energy storage, simplified operation (if MS well handled)

LCOE lower than 140 €/MWh with 7 hours storage (first results of tender results)

EDF EN CSP PROJECT IN MOROCCO

DERIVED FROM IVANPAH 150 MWE PLANT IN USA

