

Les machines hydrauliques pour compenser l'intermittence

EJC: 26/11/2013
Farid Mazzouji

POWER | **ALSTOM**

Xiang Jia Ba 812 MW, 100m

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Record du monde

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Le réseau électrique est en train de changer

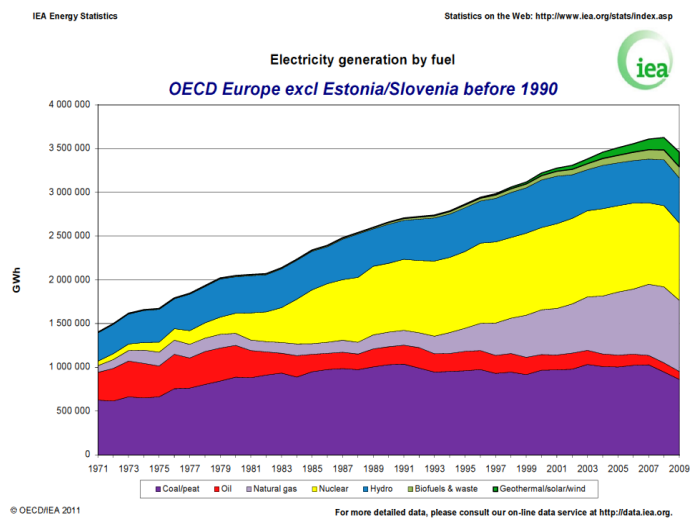
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- Intégration massive d' énergies renouvelables intermittente
- Le mix électrique est en phase de transition
 - Du charbon + nucléaire vers les NER
 - L'hydro-électricité (y compris les step) joue un rôle clé dans l'intégration des NER dans le réseau
 - Efficacité énergétique en génération et en stockage
 - Rapidité
 - stockage massif
- La R&D avance pour assurer
 - L'élargissement des domaines de fonctionnement
 - La robustesse et la fiabilité

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Le mix électrique en Europe de 1971 to 2009

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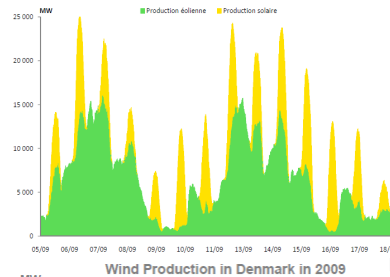


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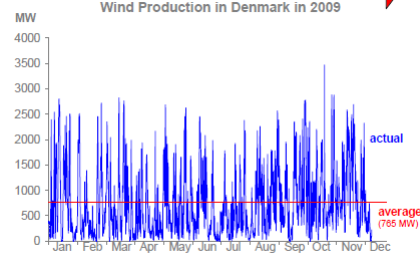
L'intermittance



- Allemagne, Sept. 2011



- Danemark, 2009

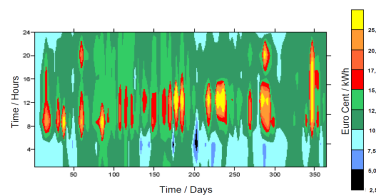


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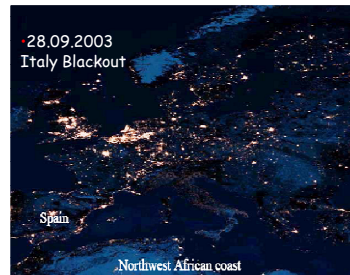
Accroissement des difficultés La stabilité du réseau et la sécurité de l'offre



- 64 GW Wind Power in Europe (2010)
- 27 GW in Germany
- 20 GW in Spain
- etc.
- Grid Stability ?
- Security of Supply ?



Source: Fritz Crotogno, KBB Hannover



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Innovation en hydroélectricité

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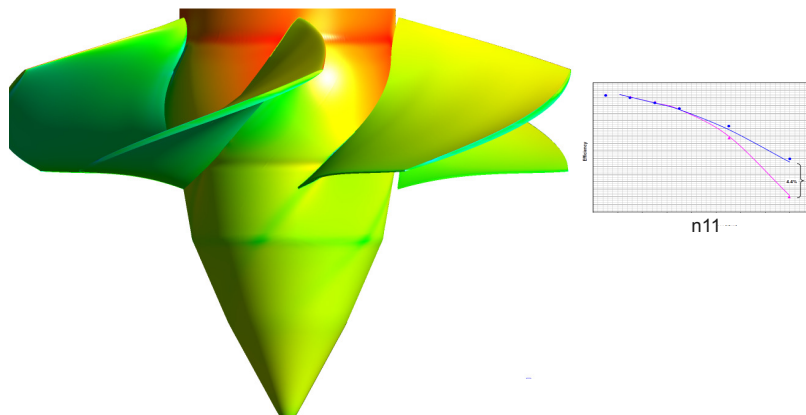


Flexibilité	Réglage en puissance 0-100%, cyclage Réactivité: temps de démarrage,...
Fiabilité	Maintenance préventive: « condition monitoring » Matériaux,...
Performance	Alternateurs: => rendement 99% Turbines: => rendement 96%

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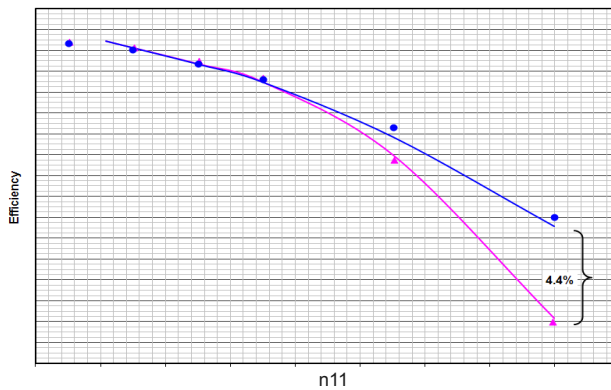
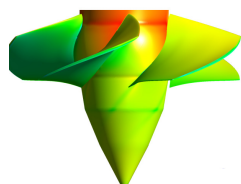
L'usage de l'analyse numérique

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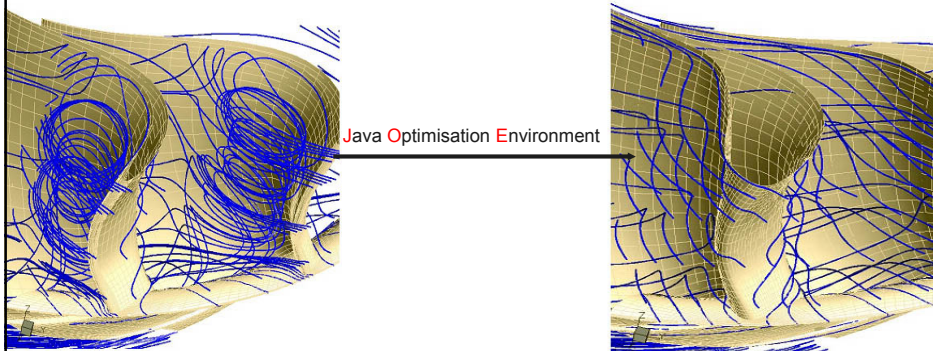
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est de plus en plus robuste

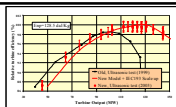


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La Simulation Et mon ami Joe



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+ 25% puissance!, + 3% rendement

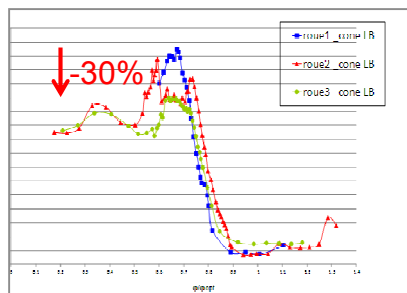


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Les design modernes diminuent les fluctuations de pression



- Des design qui diminuent les fluctuations

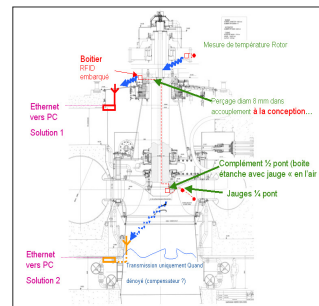


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Fatigue et durée de vie

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- Evaluation des contraintes dynamiques et des durees de vie
 - simulation
 - essai modeles
 - essai sur des machines industrielles



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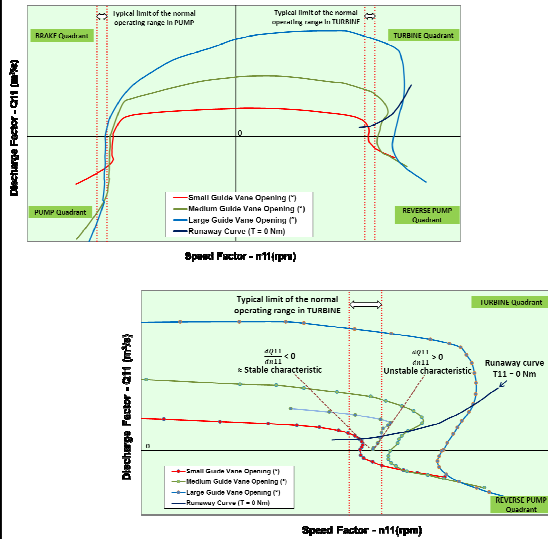
Des solutions existent

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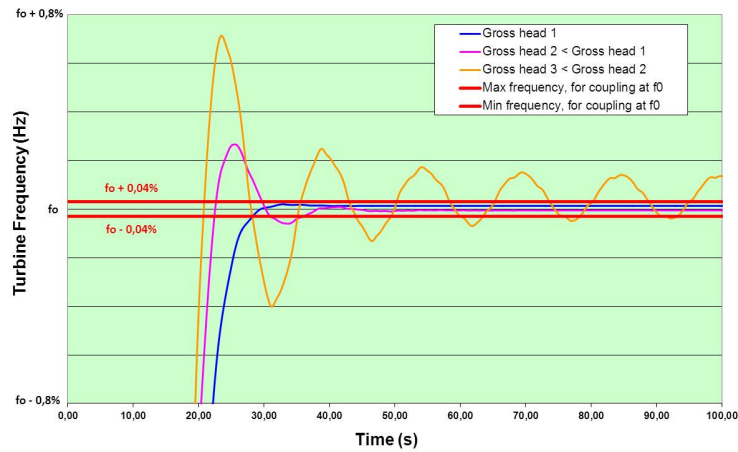
Caractéristique d'une pompe-turbine de haute chute **ALSTOM**



- Courbe caractéristique en S typique
- instabilité au couplage vers les basses chutes

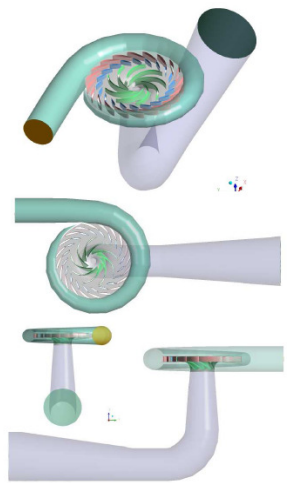
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Reduire le S de la caracteristique = stabilité **ALSTOM**



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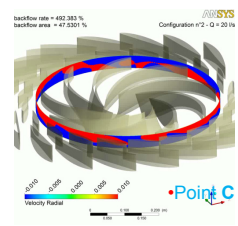
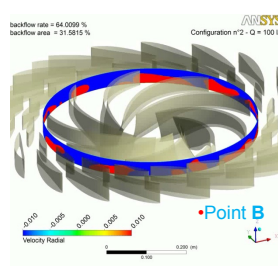
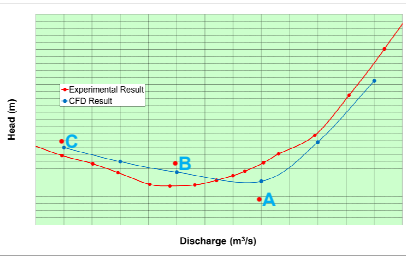
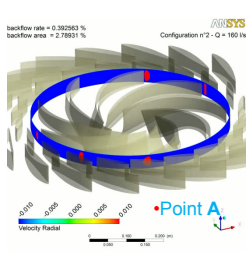
Courbe en "S" : Analyses numeriques



- Instabilité captée par la simulation numérique
- Calculs instationnaires
- 10 Mnds < maillages < 20 Mnds

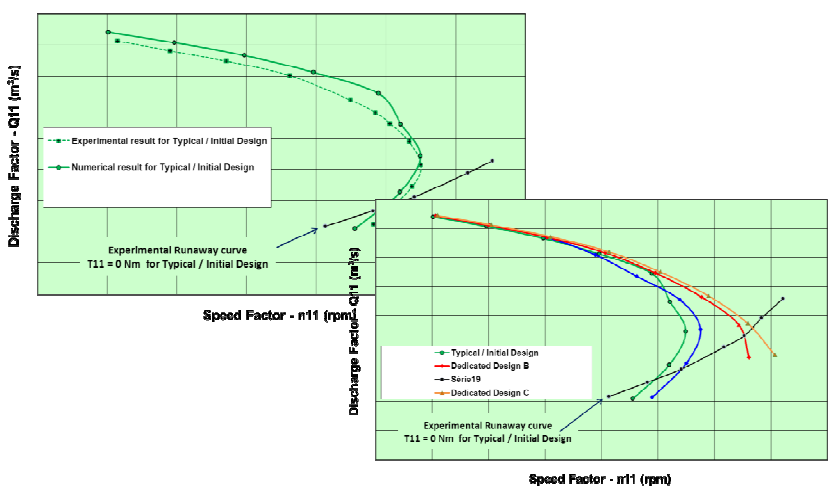
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Courbe en "S" : Analyses numeriques



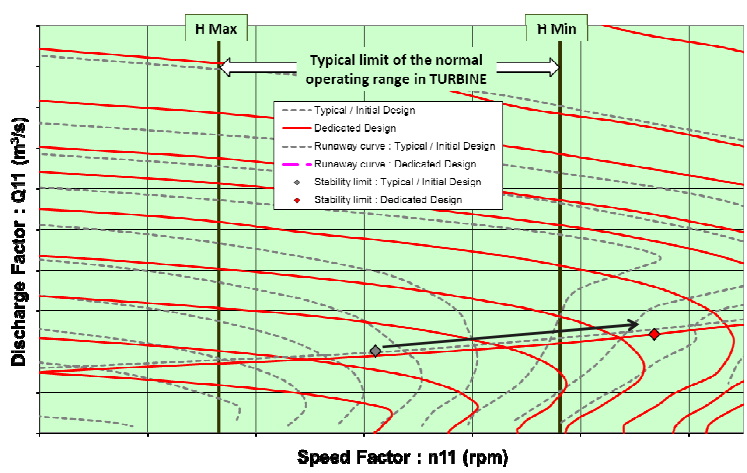
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Courbe en "S" : Analyses numeriques



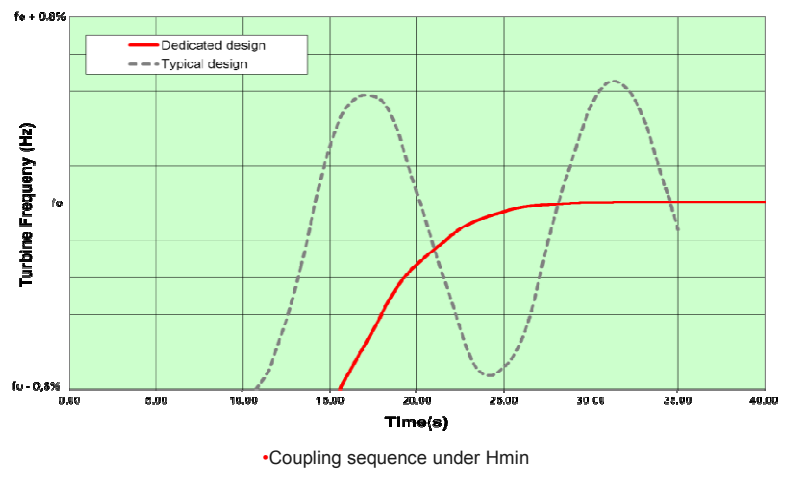
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Reduction de la courbe en "S"



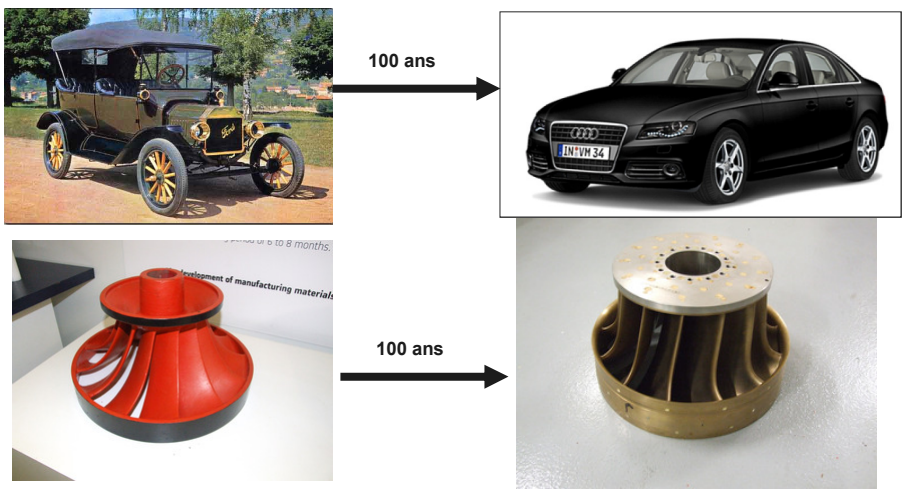
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Couplage plus rapide et plus stable



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Hydro est à la pointe de l'innovation



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