Aalborg Universitet

AALBORG UNIVERSITY
DENMARK

Predictability of the Power Output of Three Wave Energy Conversion Technologies in the Danish Part of the North Sea

Chozas, Julia Fernandez

Publication date:
2011

Document Version
Accepted author manuscript, peer reviewed version

Link to publication from Aalborg University

Citation for published version (APA):
Chozas, J. F. (2011). *Predictability of the Power Output of Three Wave Energy Conversion Technologies in the Danish Part of the North Sea*. Poster presented at The 5th Annual Symposium on International Network on Offshore Renewable Energy 2011 (INORE), Alcoutim, Portugal.

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

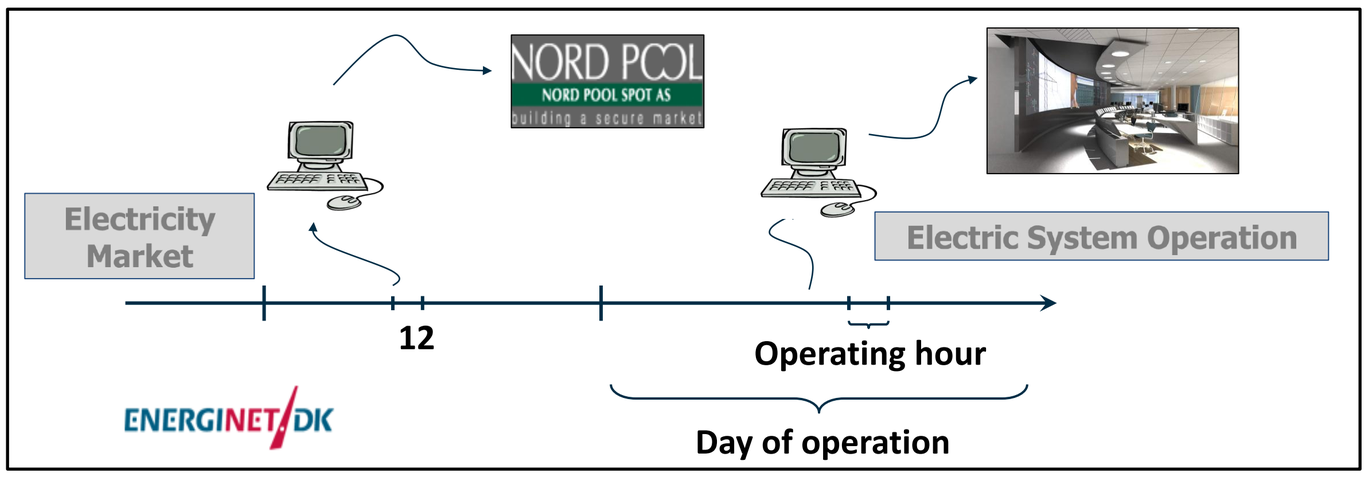
Take down policy
If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from vbn.aau.dk on: April 23, 2024

PREDICTABILITY and VARIABILITY of the POWER OUTPUT of SELECTED WAVE ENERGY TECHNOLOGIES in the NORTH SEA

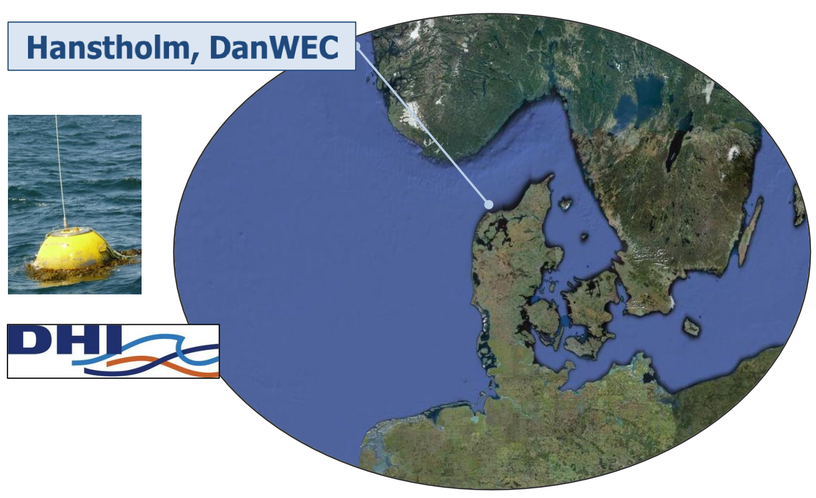
MSc. Julia Fernández Chozas (PhD Student)

- Integration of wave energy into the electricity market requires **day-ahead** forecast
- Danish day-ahead market: **12-36 hours forecast**
- **Nord Pool** rules



- Integration of wave energy into the electric grid operation requires **short-term** forecast
- Danish grid operation: **0-1 hour forecast**

LOCATION



- **Hanstholm site, Denmark**
- **17 m water depth and 1.3 km offshore**

STATISTICAL PARAMETERS

$$Mean = \frac{1}{N}\sum_{i=1}^{N} OBS_i$$

$$Bias = \frac{1}{N}\sum_{i=1}^{N} (MOD - OBS)_i$$

$$AME = \frac{1}{N}\sum_{i=1}^{N} (|MOD - OBS|)_i$$

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N} (MOD - OBS)_i^2}$$

$$SI_{unbiased} = \frac{\sqrt{\frac{1}{N}\sum_{i=1}^{N} (MOD - OBS - Bias)_i^2}}{Mean}$$

$$CC = \frac{\sum_{i=1}^{N} (MOD_i - \overline{MOD})(OBS_i - Mean)}{\sqrt{\sum_{i=1}^{N} (MOD_i - \overline{MOD})^2 \sum_{i=1}^{N} (OBS_i - Mean)^2}}$$

WAVE ENERGY CONVERTERS

Pelamis

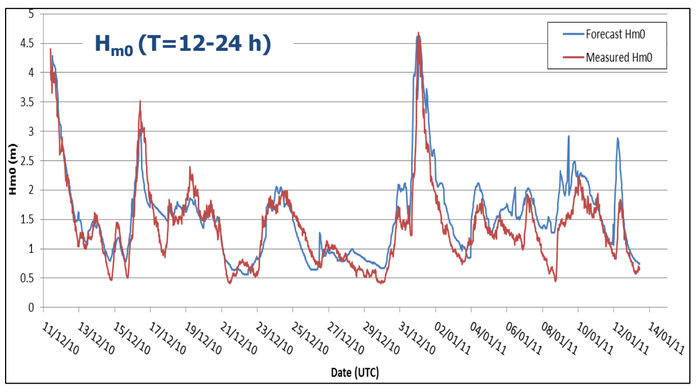
Wavestar

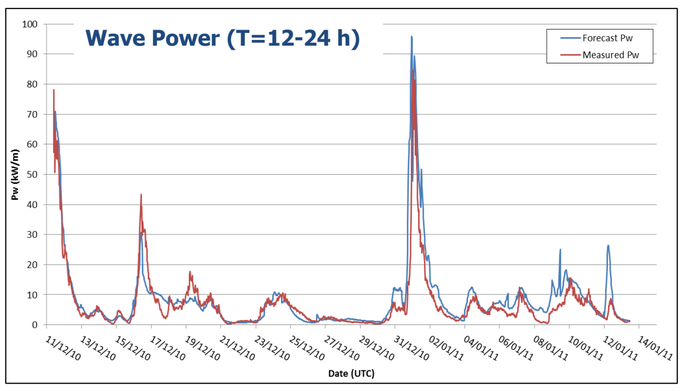
Wave Dragon

PREDICTABILITY

- **Error statistics** of wave parameters forecast
- **12-36 hours forecast**
- **Very acceptable** predictions

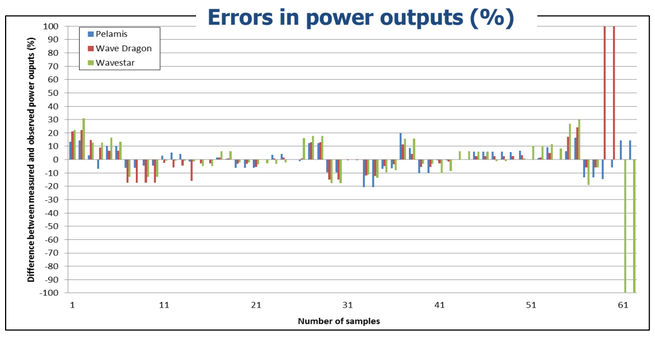
	Mean	Bias	AME	RMSE	$SI_{unbiased}$	CC	N
H_{m0} (m)	1.4	0.18	0.28	0.35	0.21	0.89	11901
T_{02} (s)	4.6	-0.17	0.42	0.56	0.11	0.74	11901
P_w (kW/m)	7.2	1.5	3	5.2	0.65	0.87	11901

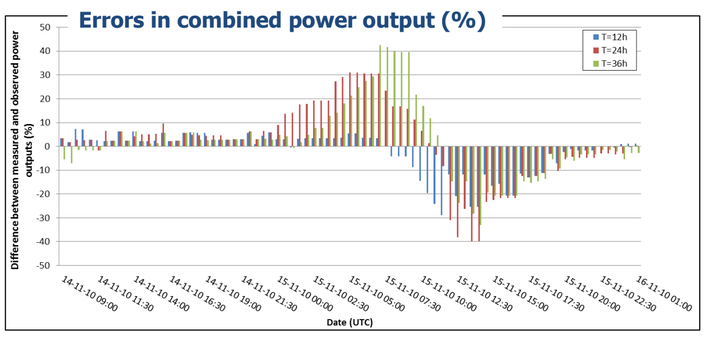




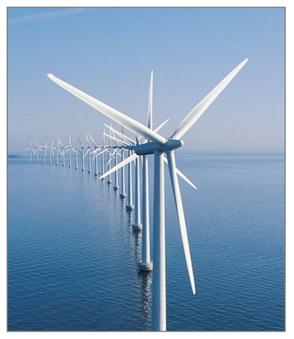
- **Error statistics** of the normalised theoretical power outputs of 3 WECs and a combination of the three of them
- **12-36 hours forecast**
- **Best** forecast when **combined power productions**

	Mean (-)	Bias (-)	AME (-)	RMSE (-)	$SI_{unbiased}$	N
Pelamis	0.29	0.07	0.11	0.15	0.44	11901
Wave Dragon	0.28	0.04	0.09	0.15	0.52	11901
Wavestar	0.39	0.04	0.15	0.24	0.62	11901
Combined	0.32	0.04	0.10	0.15	0.44	11901

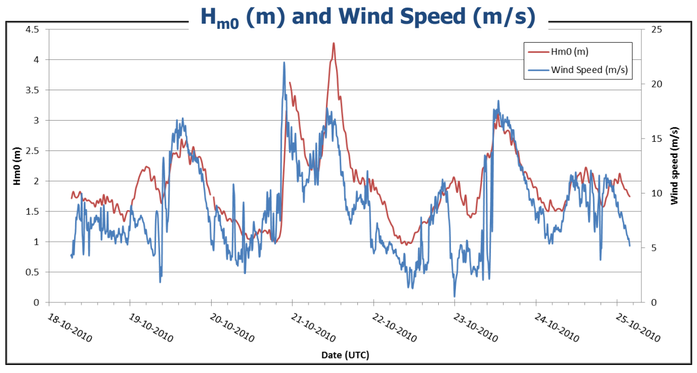




VARIABILITY



- **Pelamis**
- **Wave Dragon**
- **Wavestar**



- **Delay** between wave and wind
- Variability **smoothens** out
- **Better** accumulated **forecast**
- WECs continue **production when** wind **turbines cut-off**

❑ **Combined power output → Best forecast accuracy and High mean power production**

❑ **Forecast errors on H_{m0} and T_{02} do not accumulate - WECs respond different to predictions**

❑ **Improved results expected when wind added**

Looking forward to know more about it????!!!!!!!!
See you at EWTEC!!!!!

9th EWTEC 2011 European Wave and Tidal Energy Conference Series

S.P.O.K

AALBORG UNIVERSITY

ENERGINET.DK

MARIE CURIE ACTIONS