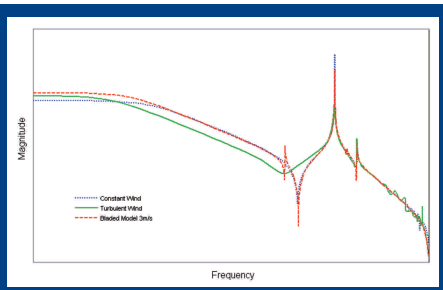
cener
centro nacional de energías renovables
national renewable energy centre

CONTROL UNIT

Wind Turbines Closed Loop Identification:

- Reducing the gap between theoretical models and real wind turbines
- Trustful and safe procedure for obtaining control oriented models
- Avoiding rules of thumb for in site controller design
- Now it is possible to design models based controllers
- Real robustness design and analysis is now possible
- Faster wind turbine commissioning
- Obtain realistic physical parameters



Models obtained with closed loop identification procedure and algorithms of CENER

Control Algorithms Design for Onshore/Offshore Wind Turbines:

- Torque controllers for load reduction and power maximization
- Collective pitch controllers
- Individual pitch controllers
- Tower damping algorithms for load reduction
- Strategies for extreme loads reductions

Rotating hub Fx	Rotating hub Fy	Rotating hub Fz	Rotating hub Mx	Rotating hub My	Rotating hub Mz
2,93	-0,16	-0,08	0,32	26,36	26,35
Stationary hub Fx	**Stationary hub Fy**	**Stationary hub Fz**	**Stationary hub Mx**	**Stationary hub My**	**Stationary hub Mz**
2,93	-1,90	-3,16	0,32	7,91	10,68

IPC Blade station radius	Blade Fx	Blade Fy	Blade Fz	Blade Mx	Blade My	Blade Mz
1,5m	16,,68	-0,19	0,03	-0,26	19,01	10,98
14m	18,04	-0,20	-0,05	-0,54	19,15	15,80
30m	18,56	-0,73	-0,01	-1,55	18,82	18,71
44m	17,98	-1,44	-0,05	-1,66	15,70	18,88

Tower station height	Tower Fx	Tower Fy	Tower Fz	Tower Mx	Tower My	Tower Mz
120m (tower top)	1,42	0,25	-2,88	0,23	7,08	10,61
0m (towe base)	-2,30	-0,20	-2,88	0,03	1,93	10,62

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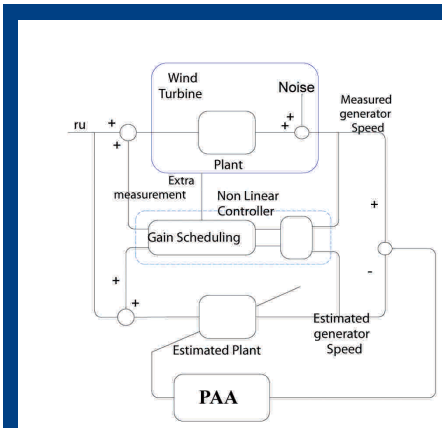
In order to achieve robust controllers, trustful stability limits, load reduction and power optimization, wind turbine controllers design requires the availability of reliable control oriented linear models for model based controller design.

Model identification of wind turbine, while operating in closed loop, is the most appropriate solution which has recently shown its capabilities for obtaining reliable linear control oriented models. The use of a controller during the execution of the experiments warranties the stability and integrity of the WT.

No more rules of thumb or trial and error controllers tuning methods with unknown control performances will be needed. Model based controllers will be designed for each in site Wind Turbine, onshore and offshore, reducing the commissioning time and increasing the reliability of the controllers and its performances.

No matter the complexity of the control scheme or the control loop is used in the WT: non linear controllers, cascade controllers, filtering..., now CENER has closed loop identification algorithms for the main control loops of the wind turbines: torque loop, pitch loop, tower damping, drive train damping…



Closed Loop Identification algorithm for non linear controllers.

Cost-effectiveness of wind turbines drives designers towards larger, lighter, more flexible structures, where control systems play an important role in actively reducing the applied structural loads, avoiding the need for wind turbines to simply withstand the full force of the applied loads through the use of stronger, heavier and therefore more expensive structures.

Controller designs can dramatically reduce both fatigue loads and extreme loads. Specific control strategies like Individual Pitch Control or Tower damping algorithms can obtain fatigue loads reductions between 15% and 30% in different WT components. Important extreme loads reduction can also be obtained with the smart design of the control algorithms in blades, hub and tower top as well as tower base, while no negative effect on WT production.

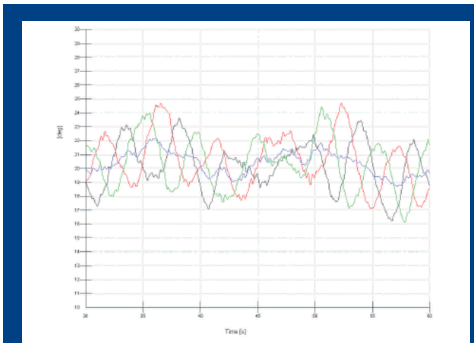


Figura 2: Comportamiento del pitch de las palas con IPC

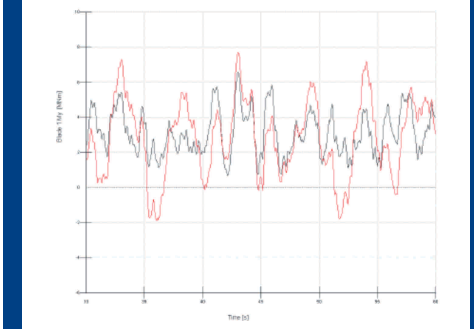


Figura 3: Cargas My en raiz de la pala con y sin IPC (lineas negra y roja respectivamente)

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