

Key Performance Indicators

Wind Farm Availability

TIME vs ENERGY



IBERDROLA

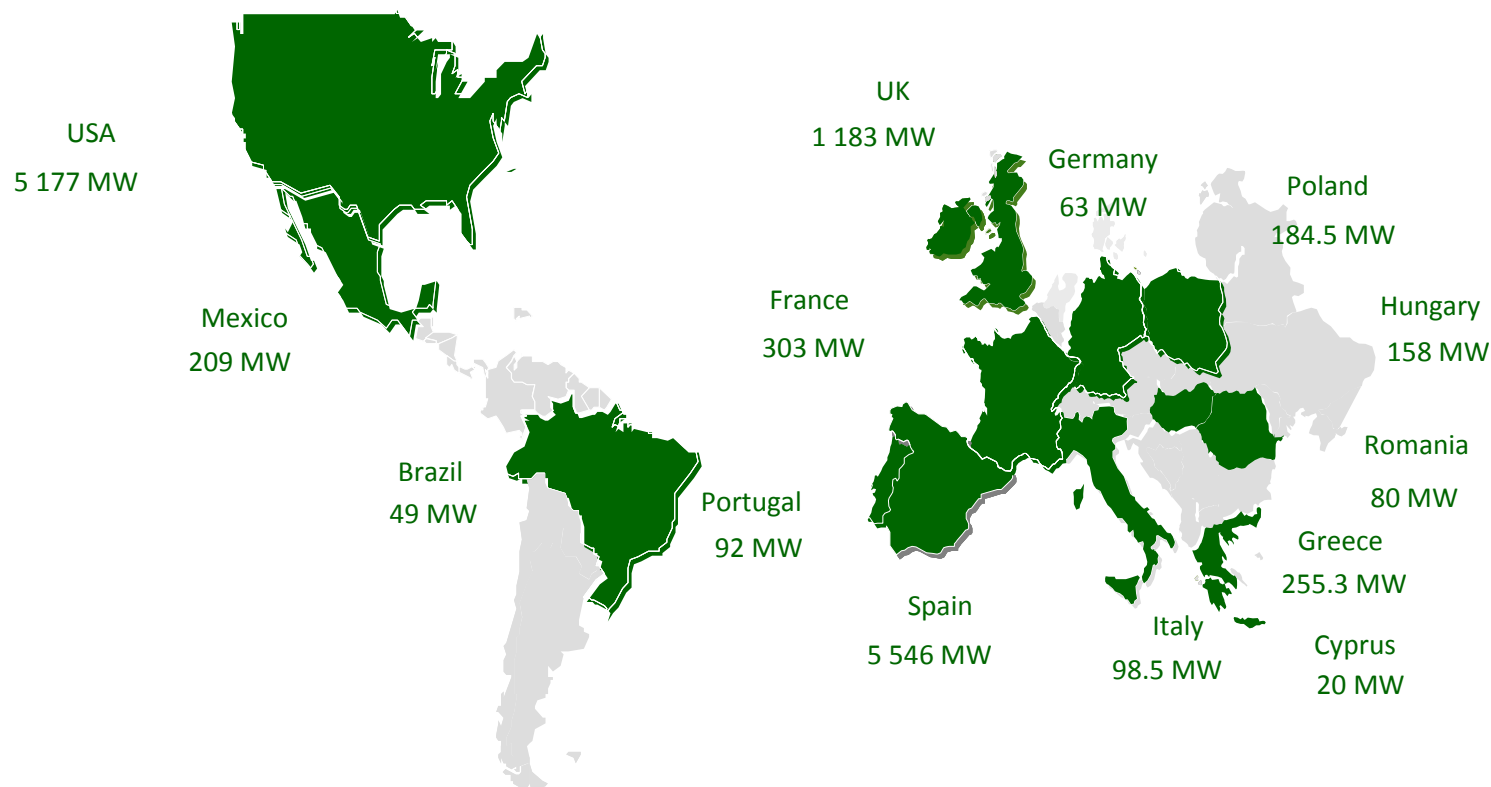
2 Julio 2012

Index

1. Iberdrola Wind Energy Overview/Portfolio
2. Wind Farm Availability
3. Conclusions

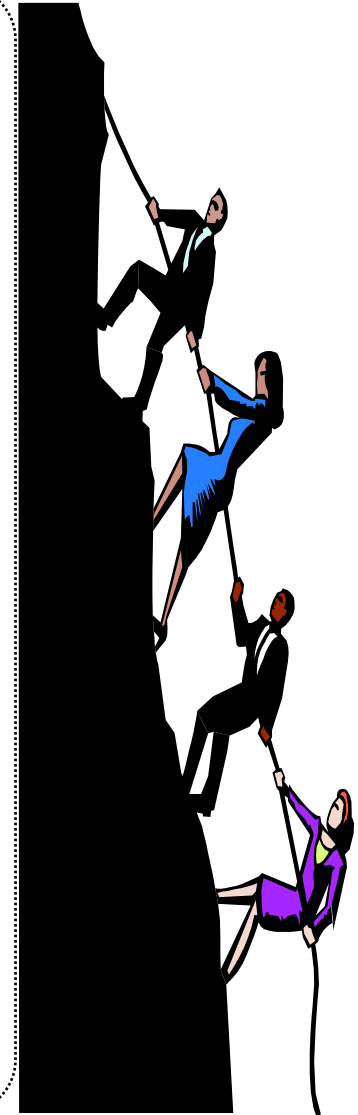
1. Iberdrola Wind Energy Overview/Portfolio

- > **13 500 MW** Wind Energy
- **13** Different Turbine Manufacturers
- **350** Wind Farms
- **16** Different Countries



1. Iberdrola Wind Energy Overview/Portfolio: **Challenges**

- Develop standard and global solutions for the Asset Management during Commercial Operation, regardless of their location or size.
 - **One company, only one way of working!**
- Create common automatic tools which facilitate the Wind Asset Management such as Standard Indicator Calculations, Stoppage Characterization, etc.
- Help detect problems in real time, in order to minimize the action times and maximize the production.
- Create corporate culture. The experiences gained, can be shared across the entire business to support overall optimization of our assets.
 - **All of this, in the same way for > 13 500 MW!**



2. Wind Farm Availability

The Availability of a Wind Farm is possibly the most popular *KPI* used to follow the performance of a Wind Farm.

Availability indicators:

1. Contractual Availability
2. Standard in-house Availability indicators:
 - ✓ **Time-based Availability (traditional one)**
 - ✓ Operational Range Time based Availability
 - ✓ **Energy-based Availability**

The **Wind Farm Energetic Unavailability** should be the final goal of the standardization on the availability indicators development process.

2. Wind Farm Availability

Contractual Availability signed between the owner and the turbine manufacturer. It is used to manage the agreements within the contract.

- ❖ Possible **penalties** depending on the figures
- ❖ Only causes attributable to the manufacturer **are considered** within the formula
- ❖ **One Availability** per manufacturer. Difficult to benchmark within the whole fleet
- ❖ Normally (today) **based on Time** at all Onshore sites
- ❖ Difficulties in double checking the figures. Potential problems and disagreement with manufacturers

Is the Contractual Availability enough for checking Wind Farm Performance?

We do not agree.... Why?

2. Wind Farm Availability

Standard in-house Availability indicators calculated in-house with internal procedures and development.

- ❖ *Same formula for the **Whole Fleet**. All Wind Farm downtime and performance issues are characterized according to a **Standard Procedure***
- ❖ ***Easy and automatic calculation, independent to manufacturers and to the SCADA data***
- ❖ *Every month all the Availability figures are automatically **published in the internal reporting tools** (also standardized)*
- ❖ *Easy to **benchmark** areas, size, site, etc...*
- ❖ *Powerful information to double check Manufacturer /Contractor Availability figures*

STANDARD AVAILABILITIES BASED ON **TIME & ENERGY** have been calculated in IBERDROLA for many years

2. Wind Farm Availability

➤ Availability based on TIME

$$A_{Time} = \frac{T_{Operation}}{T_{Period}}$$

Advantages

- ❖ *EASY and Simple calculation method*
- ❖ *Widespread within the industry*
- ❖ *Able to double check with Contractor and Manufactures Availabilities*

Drawbacks

- ❖ *Unable to detect poor planning at preventive / scheduled maintenance*
- ❖ *Unable to take into account the impact of having wind speed, or not during corrective maintenance*
- ❖ *Unable to detect potential performance issues during running periods*
- ❖ *Not possible to evaluate the impact of partial curtailments from TSO's*

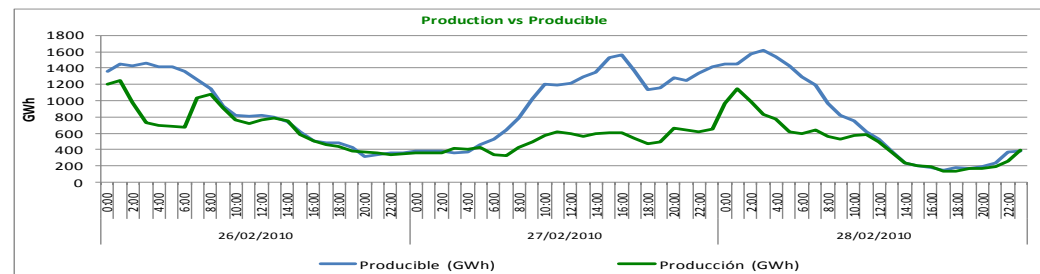
Is the Availability based on TIME enough for checking the Wind Farm Performance?

We do not agree.... Why?

2. Wind Farm Availability

➤ Availability based on ENERGY

$$A_{Energy} = \frac{E_{Real}}{E_{Theoretical}}$$



Advantages

- ❖ *Detect poorly Scheduled Maintenance / Improved Preventive Maintenance*
- ❖ *Detect Performance Issues when the Wind Turbine is running*
- ❖ *Evaluate the impact from TSO's curtailments*
- ❖ *Incentives for maintenance suppliers*

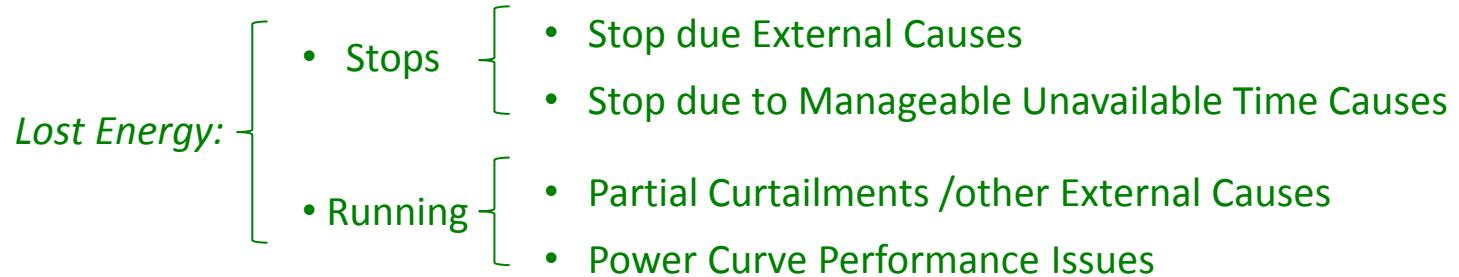
Drawbacks

- ❖ *More difficult calculation, more variables required:*
 - ✓ *Actual Production and Potential Generation*
- ❖ *Potential problems on the accuracy of the models for pot. Gen.*
- ❖ *Multiple methods of calculation*
- ❖ *New, not widespread for maintenance suppliers*



3. Conclusions

❖ Results expected:



❖ **In-house Availability Indicators** are convenient.

❖ Calculation within the Availability based on Time does **not present Major Difficulties**, for this reason is being used as a reference point for Wind Farm Performance in most cases.

❖ Energetic Availability **goes a step further** in terms of a Wind Farm performance indicator, bringing out energy losses instead of downtimes.



THANK YOU ALL
FOR YOUR ATTENTION



IBERDROLA

2 Julio 2012