



Managing Assets for the Long-Term

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17th November 2015

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Operations Team

Operating Excellence



Operation of assets with a long-term view focused on value



Unique renewable System Operation Center (CECOER)
that maximizes production



Broad technological know-how and capabilities to operate and maintain
all types of turbines



Outstanding combination of scale and agility



Best-in-class operational efficiency

Operations Team

Main Strategic Principles

Long-term vision

- **Maximize turbine useful life**
- **Emphasis on preventive and conditioned maintenance** over corrective maintenance
- **Active fleet maintenance risk management** ("Maximo tool")

Production increase

- Average of **98% availability in 2015**
- O&M contract performance ratios linked to **availability and speed of response**
- Enhance the **development of technical solutions to improve grid integration** including: predictive modeling, remote fault response, and portfolio management effects

O&M cost efficiency

- **Increase efficiency and complexity** through permanent internal benchmarking and cost reduction programs (\$/MWh)
- **Economies of scale** driven by global purchasing and logistic services

Selective outsourcing level

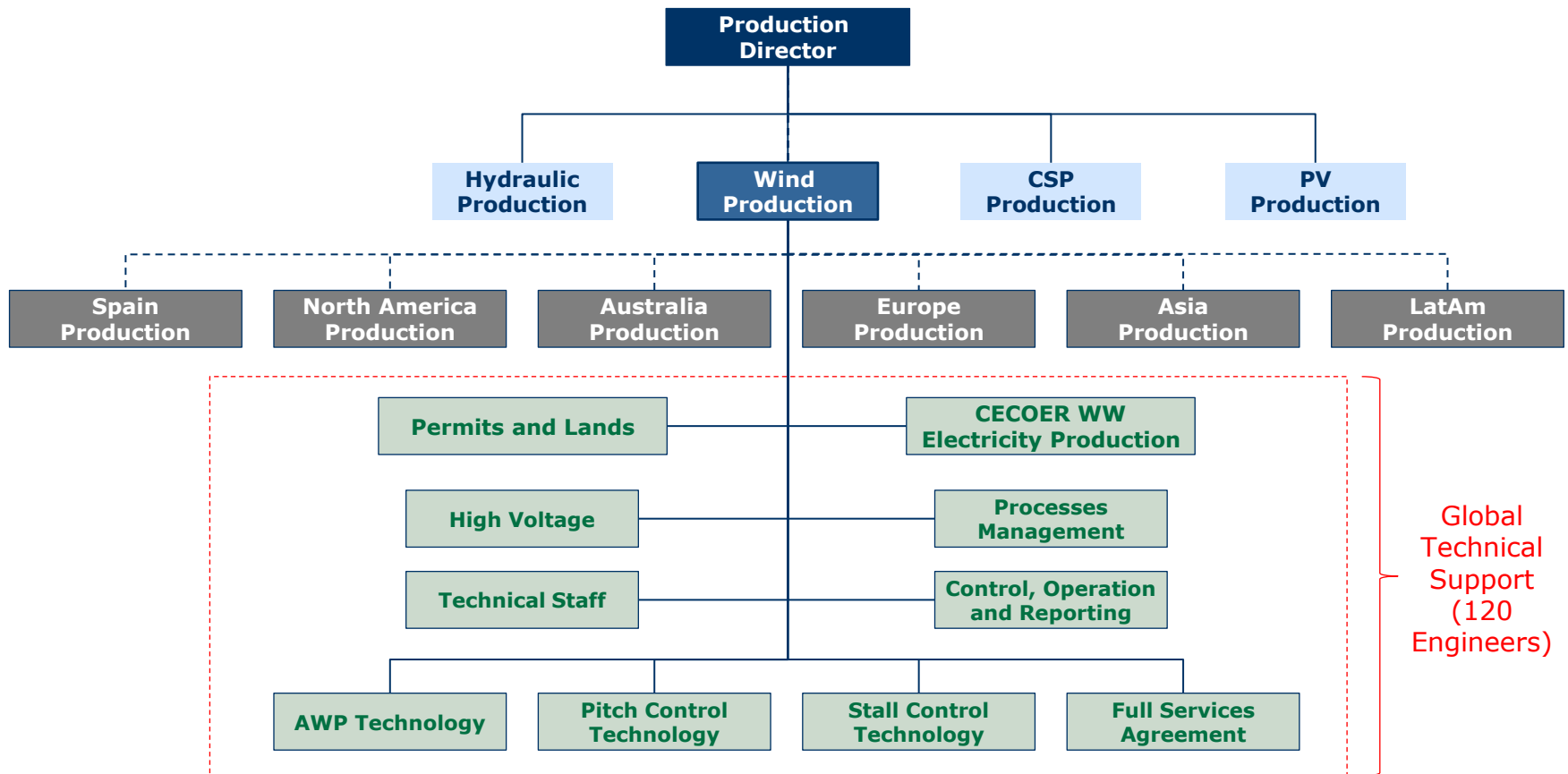
- Outsourcing level adapted to different geographies and turbine models
- Preference for in-house management of key activities, based on existing know-how and capabilities (retain in-house value-added activities)

Operational risk coverage

- Exhaustive failures assessment and preventive maintenance policies in place
- Availability coverage through insurance, warranties and penalties service contracts

Operations Team Organizational Structure

Global fleet management combined with local operations maximizes knowledge transfer and captures economies of scale



Operations Team

System Operations Center—CECOER

Unique system operation center (CECOER)
globally manages operations and maximizes grid deliverability

98%+ average availability

- 11,489 MW managed
- 6+ million variables monitored
- 28+ TWh /year
- 3 locations (Chicago, Pamplona and Mexico)

Production increase, reduce imbalance charges, and maximize grid derivability

- **Response time reduction**
 - 60%+ remote-controlled solutions
- **Short term wind forecast**



CECOER. ACCIONA Energy renewable facilities control center

Operations Team

Extensive Experience in O&M (20+ years)

Scale and broad technology know-how

- **More than 9,600 MW managed**
- Management capabilities in 10 different wind technologies

Manufacturer	MW
AWP	2,852
ENERCON	319
GAMESA	2,313
GEWE	128
SIEMENS (BONUS)	401
KENETECH	31
LAGERWAY	37
MADE	446
VESTAS (NEG MICON)	629
REPOWER	10
TOTAL	7,166

Centralized and experienced maintenance engineering

- **Multidisciplinary teams** for each technology
- **Institutionalization** of technical knowledge
- **Global methodologies** and procedures
- Develop **local solutions**
- **Co-design & improvement** of wind turbine design
- Effective **support from ACCIONA Windpower** Technical Services

Global purchasing and logistics

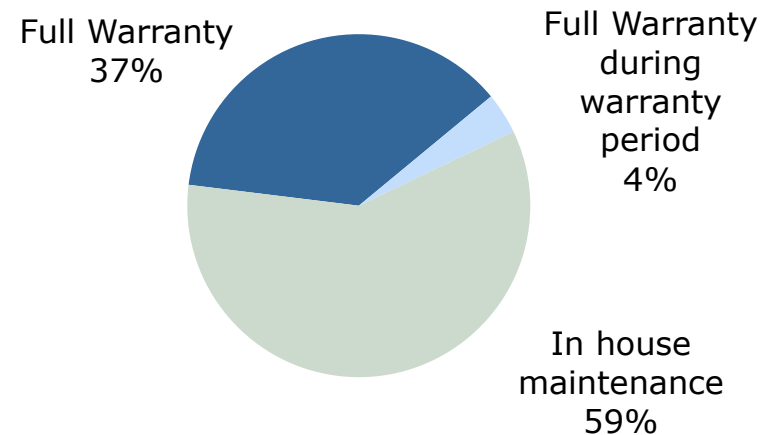
- **Strong negotiation capability** with suppliers
- **Multiple supplier options**
- **Large central spares warehouse**
- **Minimizes delivery times**

Operations Team

Portfolio Overview

O&M contracts overview

- **Optimal strategy** for each asset
- **41%** of O&M contracts are covered by full warranty where services are provided by the turbine manufacturer
- **59%** of the O&M contracts are carried out by ACCIONA Energy
- **Scope** includes:
 - Labour
 - Preventative maintenance
 - Technical supervision in the base fee
 - Spares and major corrective services are invoiced independently



Managing Assets for the Long-Term Maintenance Policy

Reach 35-year useful life with controlled maintenance costs

Monitoring critical components and their path to failure

Adapting each turbine to its site

Carrying out design modifications

Adjusting operational regimes

Tailoring maintenance plans

Managing Assets for the Long-Term

Examples of Asset Life Action Plan during 2015

Monitoring critical components and their path to failure

- Improvements in frames and orientation systems for G47 technology
- Identified wrinkles in blade root (LM21, LM23.5) MADE and NEG MICON

Adapting each turbine to its site

- Wind regime and adaptation in AW1500 and G4X technologies
- Integration of more robust and precise components: spin reducers and sonic sensors

Carrying out design modifications

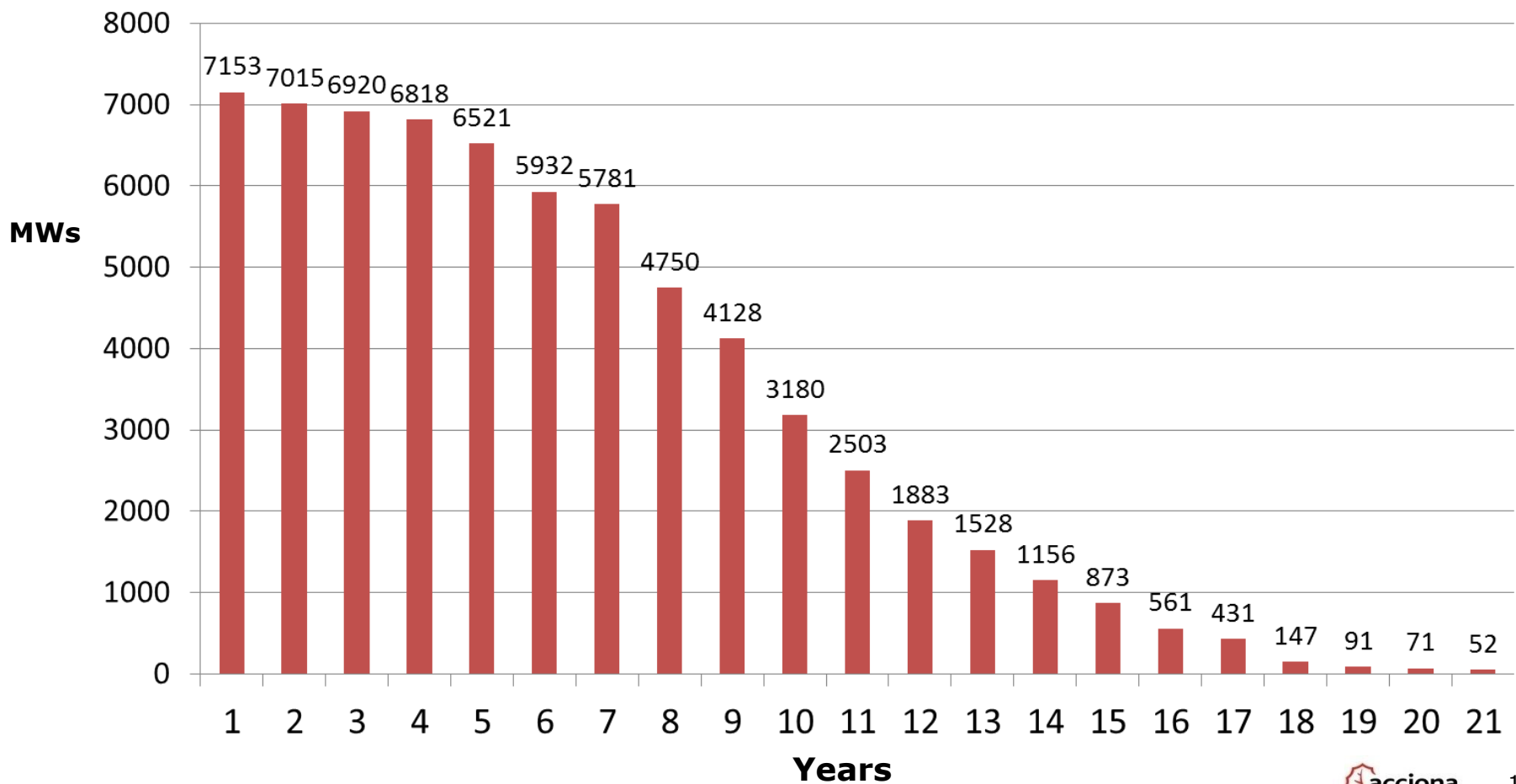
- Improvements in cooling and lubrication of gear boxes
- Improvements in geometry for load balance redistribution
- Improvement in performance and efficiency acting through the control system

Useful Life Extension

ACCIONA Wind Fleet

ACCIONA's wind fleet average consumed life: 8.6 years

MW's/AGE



Useful Life Extension

Life Extension Technical Competences

OPTIMIZATION

- Simulation and modelling
- Load monitoring
- Instrumentation and control
- Finite component analysis
- Design

MECHANICS

- Structural mechanics
- Rotating mechanics

SPECIAL TASKS

- On-turbine works, improvements and tests

ELECTRICITY and ELECTRONICS

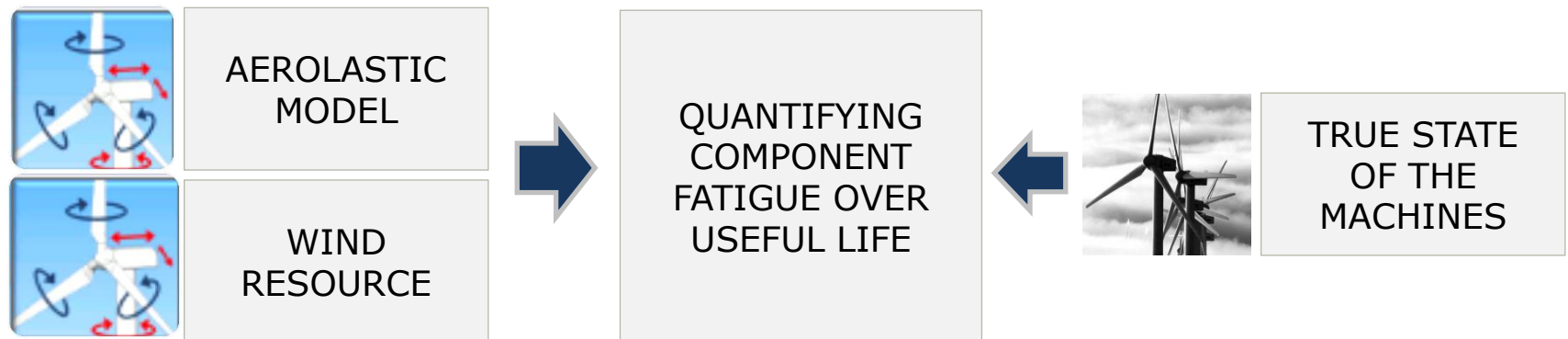
- Power curve electronics
- Rotating electronic machines
- Static electronic machines

- Composite materials
- Blades

Useful Life Extension

Evaluation of Fatigue Over Useful Life of Component

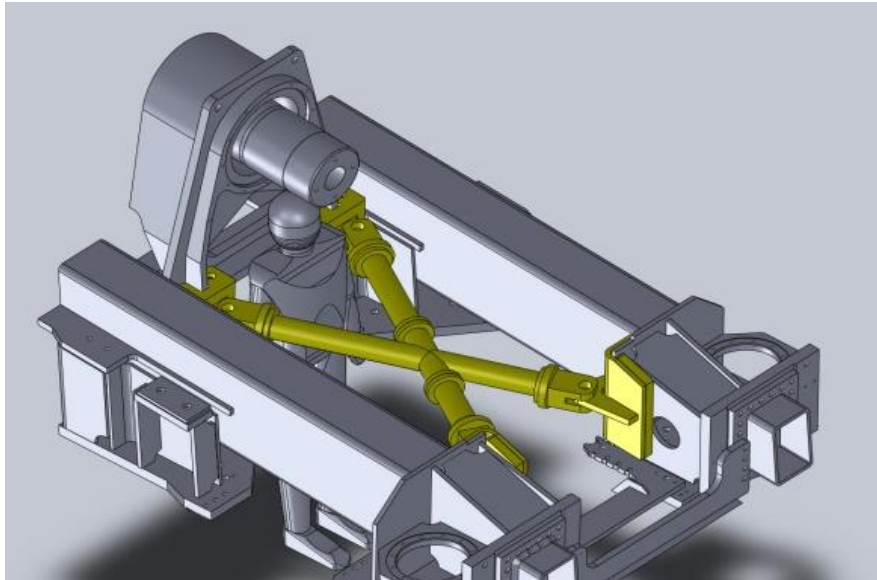
- Aerolastic modelling
- Site categorization by wind regime, specially turbulence intensity and its energy
- Constant updating and fine tuning of model through real data obtained in the field and through tests



Useful Life Extension

Reduce the Impact of Critical Trouble-spots and Failures

- Replace components or expand their useful life, avoiding failure, taking into account economic, technical and safety aspects/criteria. Impact of failure
- Redesign components y reinforcements



COMPONENT [-]	CELL A [years]	CELL B [years]	CELL C [years]	CELL D [years]	CELL E [years]
COMPOSITE BLADES					
Aluring Body	23	33	32	28	24
Aluring Bonded Joint	32	>35	>35	>35	>35
Composite Root	24	>35	35	30	26
Section R2.6	27	>35	>35	32	30
Section R4.6	>35	>35	>35	>35	>35
Section R6.6	>35	>35	>35	>35	>35
Section R8.6	>35	>35	>35	>35	>35
Section R10.6	>35	>35	>35	>35	>35
Section R12.6	>35	>35	>35	>35	>35
Section R14.6	>35	>35	>35	>35	>35
Section R16.6	>35	>35	>35	>35	>35
Section R18.6	>35	>35	>35	>35	>35
Section R20.6	>35	>35	>35	>35	>35
Section R22.6	>35	>35	>35	>35	>35
BLADE - BEARING - HUB BOLTS	20	23	23	22	20
PITCH BEARING	>35	>35	>35	>35	>35
PITCH ACTUATORS AND SUPPORTS	>35	>35	>35	>35	>35
HUB	>35	>35	>35	>35	>35
MAIN BEARING	25	>35	34	22	29
MAIN BEARING SUPPORTS	>35	>35	>35	>35	>35
MAIN FRAME	>35	>35	>35	>35	>35
DRIVE TRAIN MOUNTING	15	22	15	13	16
YAW BEARING	>35	>35	>35	>35	>35
YAW BEARING SUPPORTS	>35	>35	>35	>35	>35
TOWER					
Section H3	>35	>35	>35	>35	>35
Section H6	>35	>35	>35	>35	>35
Section H12	>35	>35	>35	>35	>35
Section H18	>35	>35	>35	>35	>35
Section H24	>35	>35	>35	>35	>35
Section H30	>35	>35	>35	>35	>35
Section H36	>35	>35	>35	>35	>35
Section H42	>35	>35	>35	>35	>35
Section H43.8	>35	>35	>35	>35	>35
FOUNDATION	>35	>35	>35	>35	>35

Case Study

El Perdón – As good as new...



Windfarm El Perdón, in Navarra. First windfarm installed by the Group (1994-1996)

Case Study

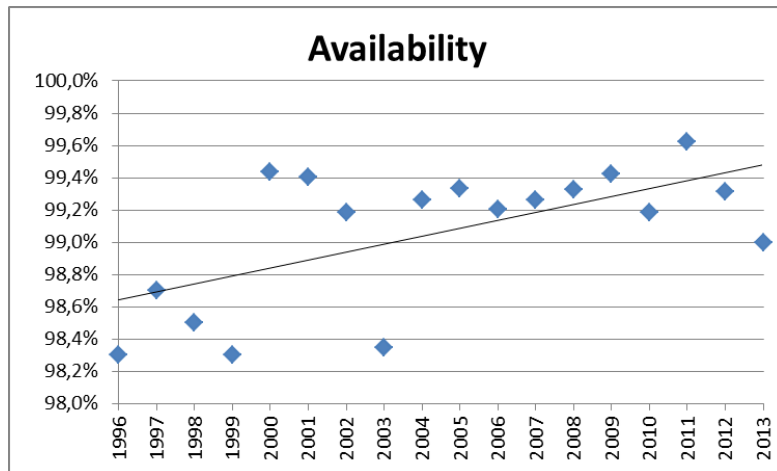
El Perdón - As good as new...

21 years of experience maintaining the WTG¹
with the same performance ratios as the first day

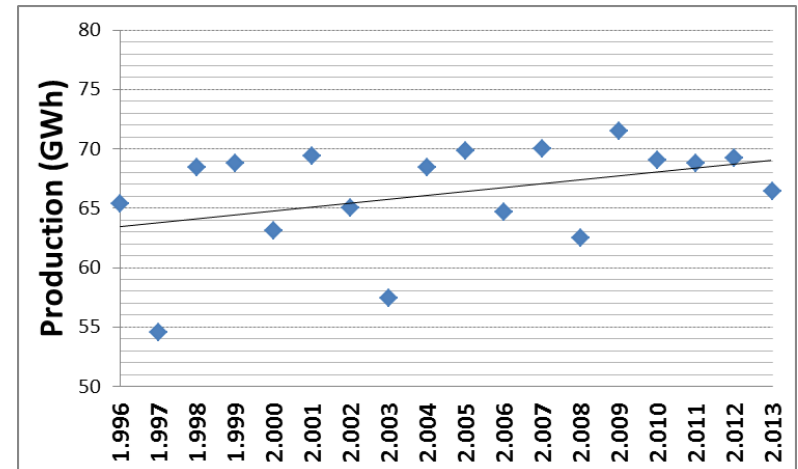
El Perdón — the first and oldest ACCIONA Energía wind farm

- Maintained to keep WTG's as new
- 40 WTG V39 500
- Began operations in 1994
- OPEX: €9/MWh in 2013; €6.9/MWh in 2014; €8.7/MWh 2015E → €8.2/MWh in last 5 years

98%+ average availability



3%+ production increase



¹ Wind Turbine Generator

Case Study

El Perdón - As good as new...

Several actions have been carried out during the 20 year life of the asset which have allowed the wind farm to operate at its full capacity

Improving performance by extending blades to 11 turbines in order to increase the rotor sweep diameter and therefore raise the energy capture

Gradual renewal and constant improvement of components over time

- 35 multipliers
- 36 generators
- Lubrication upgrades and improvements in bearing for charge distribution
- Development of a new generator with short-circuit rotor
- No blade substitution for structural deterioration, continuously repairing the most critical damages due to erosion and wearing



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