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Life time extension Project:
LTE P.E MUEL

innogy SPAIN S.A.U · 2018

1 BACKGROUND

2 OBJECTIVES

3 TIMELINE

4 SCOPE

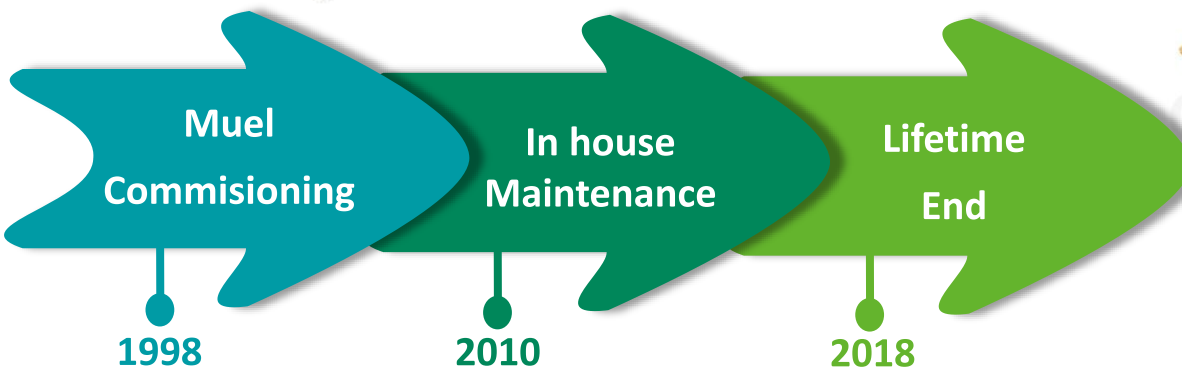
BACKGROUND

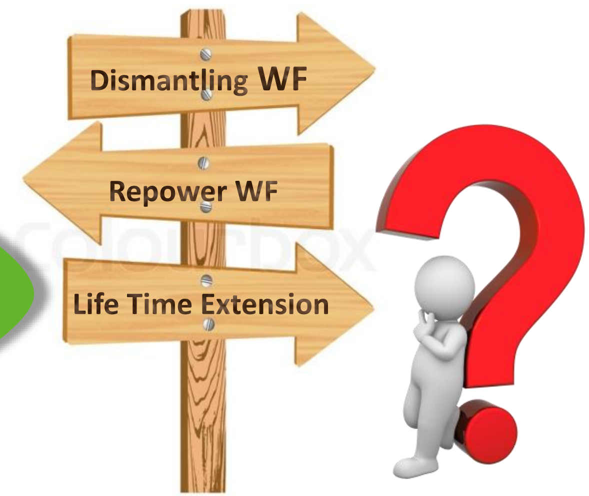
Muel Windfarm

16.2 MW

27 WTG's

NTK43/600kW





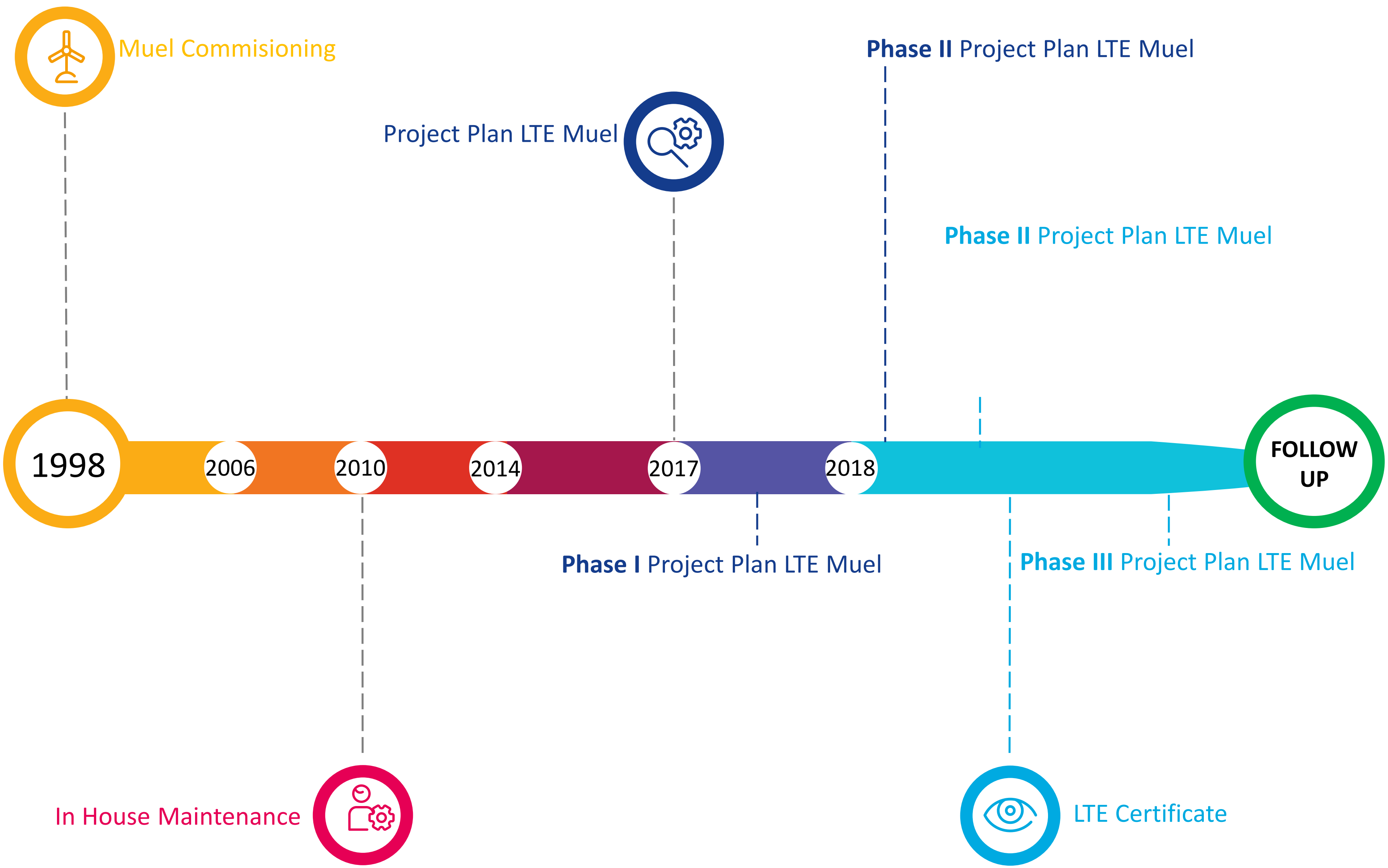
OBJECTIVES


Alignament with Innogy lessons learned in Europe:
WF Carno & WF Lichtenau
Collaboration with independent entities:
SGS & NABLA
LTE certificate extended based on O&M strategy.


LTE


STANDARD
Standard
STANDARD
STANDARD

TIMELINE


Muel Commisioning
Project Plan LTE Muel
Phase II Project Plan LTE Muel
Phase II Project Plan LTE Muel
1998
2006
2010
2014
2017
2018
FOLLOW UP
Phase I Project Plan LTE Muel
Phase III Project Plan LTE Muel
In House Maintenance
LTE Certificate

SCOPE

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	Innogy	Engeneering -Nabla	Certification Body-SGS
ANALYTICAL PHASE CER	**DOCUMENTATION** O&M Data WTG information Maintenance data Components Replaced	**TURBINE AEROELASTIC MODELING** - Wind site conditions Modeling - Operation conditions Modeling - WTG Modeling **LIFE DETECTION ANALYSIS**	**DOCUMENTARY ANALYLIS**
PRACTICAL PHASE I	**2 REPRESETATIVE WTG INSPECTION** CRITICAL COMPONENTS EXTENTION PLAN	**LIFE DETECTION ANALYLIS**	**ACTION PLAN SUPERVISION** **LIFE EXTENSION CERTIFICATE**
PRACTICAL PHASE II	**ACTION PLAN IMPLEMANETATION** MAINTENANCE PLAN ADJUSTMENT & FOLLOWUP	**INFORMATIVE FOLLOWUP**	**MAINTENANCE CERTIFICATION** **PERIODIC SUPERVISION**

LIFE ANALYSIS PROCESS

WIND CONDITIONS MODELING
- Normative vs Site-Specific
- Air Density / Seasonal Variations
- Annual Wind Distributions
- Wind Directions and Frequency
- Inflow Angles
- Wind Shear Profiles
- Turbulence

OPERATION CONDITIONS MODELING
- Number of Transients
- Yaw Misalignments
- Long Term Parking
- Ice Accretion
- Surface Degraded Conditions

TURBINE MODELING
- Geometries
- Aerodynamics and Performances
- Structures Elastics
- Structures Mass Models
- Mechanical basic modelization
- Components Overweight vs Design
- Real Controller Settings vs Design

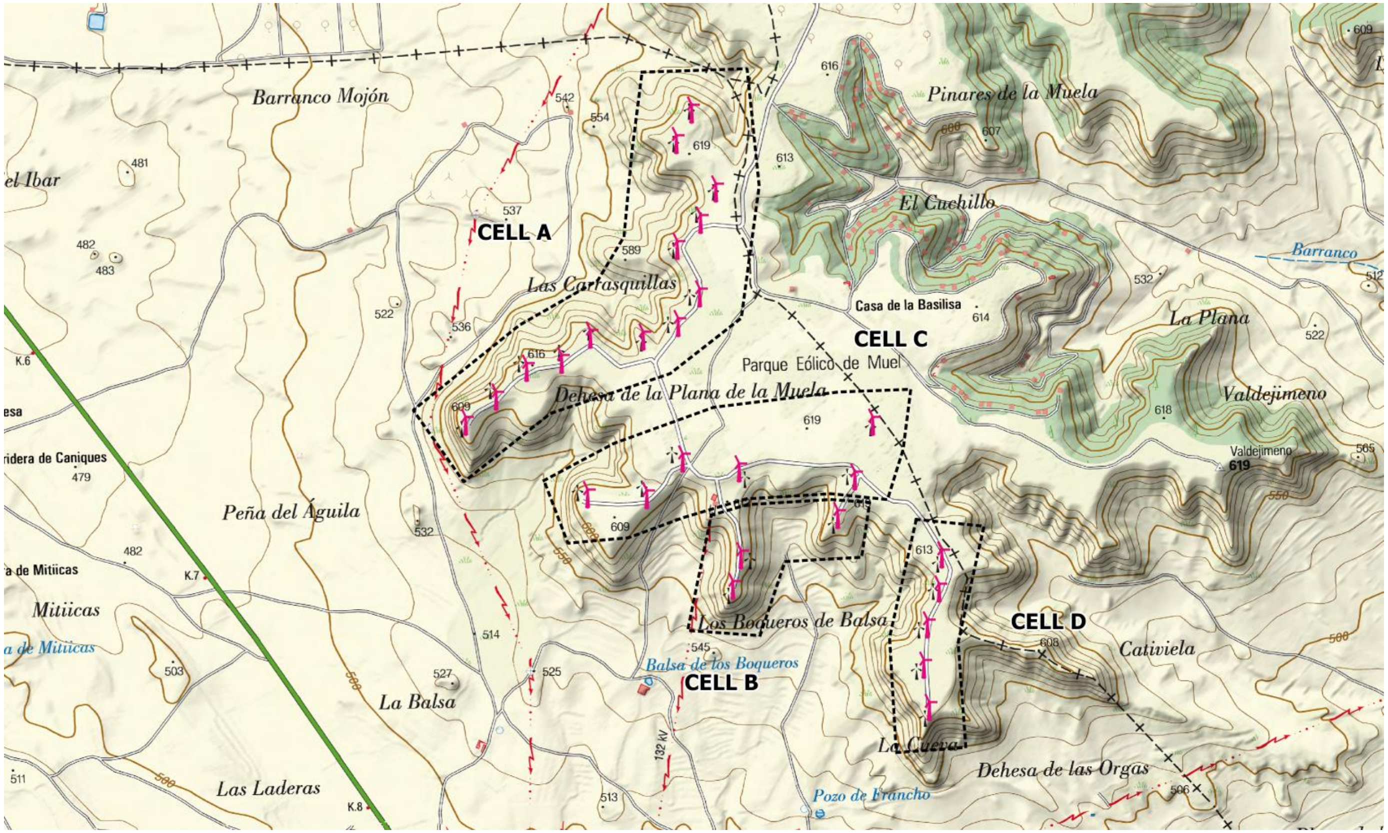
AEROELASTIC LOADS ANALYSIS
- DESIGN CONDITIONS -

AEROELASTIC LOADS ANALYSIS
- SITE SPECIFIC CONDITIONS -

LIFE DETECTION ANALYSIS
- **Per Component**
- **Design Life Redefinition based on Causes**
- **Hierarchy of main Components**

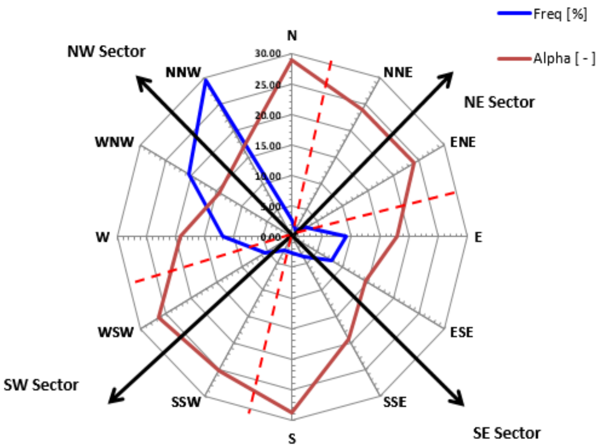
LIFE EXTENSION AND LIFE MANAGEMENT ANALYSIS
- **Based on Life-Consuming Site Specific Causes**
- **Evaluating most sensible Asset Operation Strategies**
- **Life Extension Strategies: Maximizing Produced Energy vs Life Consumption**
- **Life Management Strategies: Maximizing Produced Energy vs Market**
- **Optimizing Long Term Return of Investment**

SUBSITING

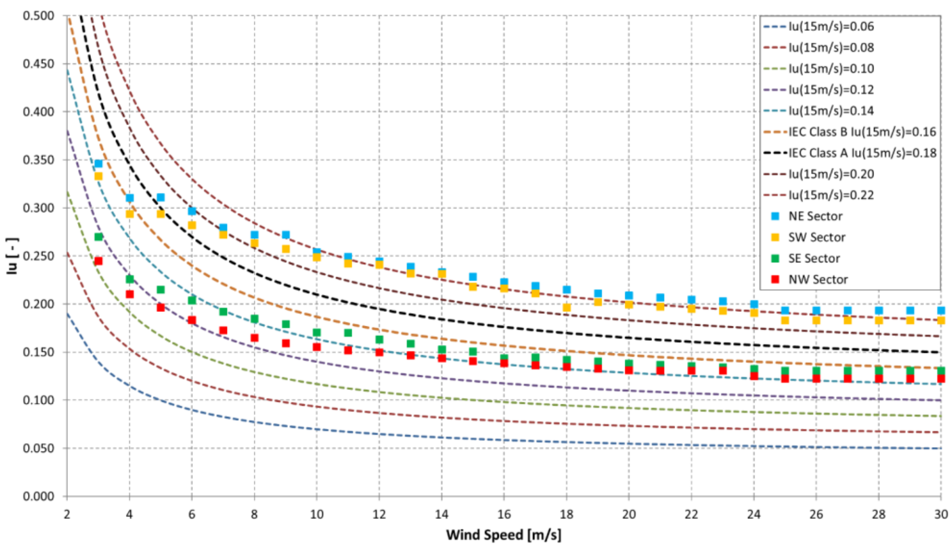

CELL A
CELL B
CELL C
CELL D
Barranco Mojón
Pinares de la Muela
El Cuchillo
Las Carrasquillas
Casa de la Basilisa
Parque Eólico de Muel
La Plana
Valdejimeno
Dehesa de la Plana de la Muela
Peña del Águila
Mitiicas
Los Boqueros de Balsa
Balsa de los Boqueros
Cativiela
La Balsa
Las Laderas
La Cueva
Dehesa de las Orgas
Pozo de Francho
Barranco
132 kV

WIND CONDITIONS (e.g. Cell A)

Rose of Wind Parameters



Turbulence Intensities



WIND CONDITIONS SUMMARY

		Wind Directions	DESIGN	Muel Cell A	Effect in Life	Nature of Source
Air Density	[kg/m3]	N/A	1.225	1.152	↑	Dominant
Weibull *a*	[m/s]	NW: 64.59%	11.28	10.36	↑	Dominant
		SE: 23.28%	11.28	5.56	↑	Dominant
		NE: 4.04%	11.28	3.87	↑	Dominant
		SW: 8.00%	11.28	5.85	↑	Dominant
Inflow Angle	[deg]	NW: 64.59%	8.0	5.0	↑	Important
		SE: 23.28%	8.0	-5.0	→	Important
		NE: 4.04%	8.0	-3.1	→	Important
		SW: 8.00%	8.0	3.1	↑	Important
Wind Shear	[-]	NW: 64.59%	0.20	0.14	↑	Dominant
		SE: 23.28%	0.20	0.15	↑	Dominant
		NE: 4.04%	0.20	0.20	→	Dominant
		SW: 8.00%	0.20	0.22	↓	Dominant
Turbulence Iu(15m/s)	[-]	NW: 64.59%	0.18	0.16	↑	Dominant
		SE: 23.28%	0.18	0.16	↑	Dominant
		NE: 4.04%	0.18	0.22	↓	Dominant
		SW: 8.00%	0.18	0.22	↓	Dominant

OPERATION CONDITIONS (e.g. Cell A)

NUMBER OF TRANSIENTS LOAD CASES

		MUEL CELL A															
		TOTAL	Overall			NW 64.59			SE 23.28			NE 4.04			SW 8.00		
			Vin	Vrated	Vout	Vin	Vrated	Vout	Vin	Vrated	Vout	Vin	Vrated	Vout	Vin	Vrated	Vout
SU	[-]	1714.4	1442.1	222.5	49.8	931.5	143.7	32.2	335.7	51.8	11.6	58.3	9.0	2.0	115.4	17.8	4.0
ES	[-]	52.0	49.0	2.0	1.0	31.6	1.3	0.6	11.4	0.5	0.2	2.0	0.1	0.0	3.9	0.2	0.1
NS	[-]	1662.4	1393.1	220.5	48.8	899.8	142.4	31.5	324.3	51.3	11.4	56.3	8.9	2.0	111.4	17.6	3.9

Table 7.3-A: Type and number of transient load cases until February 2013

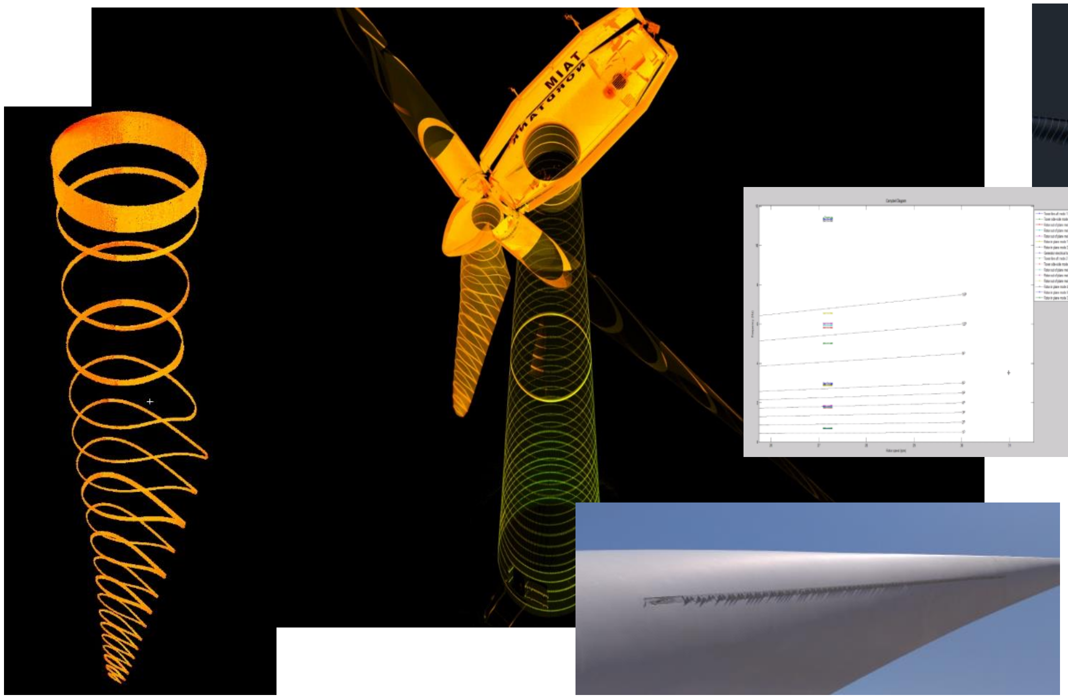
From February 2013 onwards the following conditions have been considered.

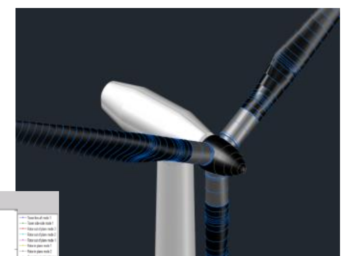
NUMBER OF TRANSIENTS LOAD CASES

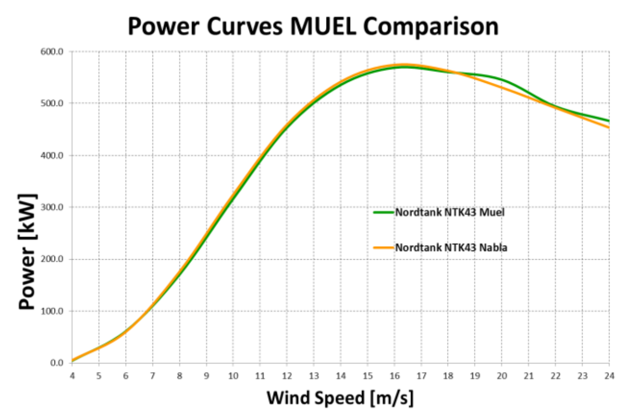
		MUEL CELL A															
		TOTAL	Overall			NW 64.59			SE 23.28			NE 4.04			SW 8.00		
			Vin	Vrated	Vout	Vin	Vrated	Vout	Vin	Vrated	Vout	Vin	Vrated	Vout	Vin	Vrated	Vout
SU	[-]	1560.3	1340.1	191.6	28.6	865.6	123.8	18.5	312.0	44.6	6.7	54.1	7.7	1.2	124.8	107.2	15.3
ES	[-]	17.0	13.2	2.5	1.4	8.5	1.6	0.9	3.1	0.6	0.3	0.5	0.1	0.1	1.4	1.1	0.2
NS	[-]	1543.3	1327.0	189.1	27.2	857.1	122.2	17.6	308.9	44.0	6.3	53.6	7.6	1.1	123.5	106.2	15.1

Table 7.3-B: Type and number of transient load cases since February 2013

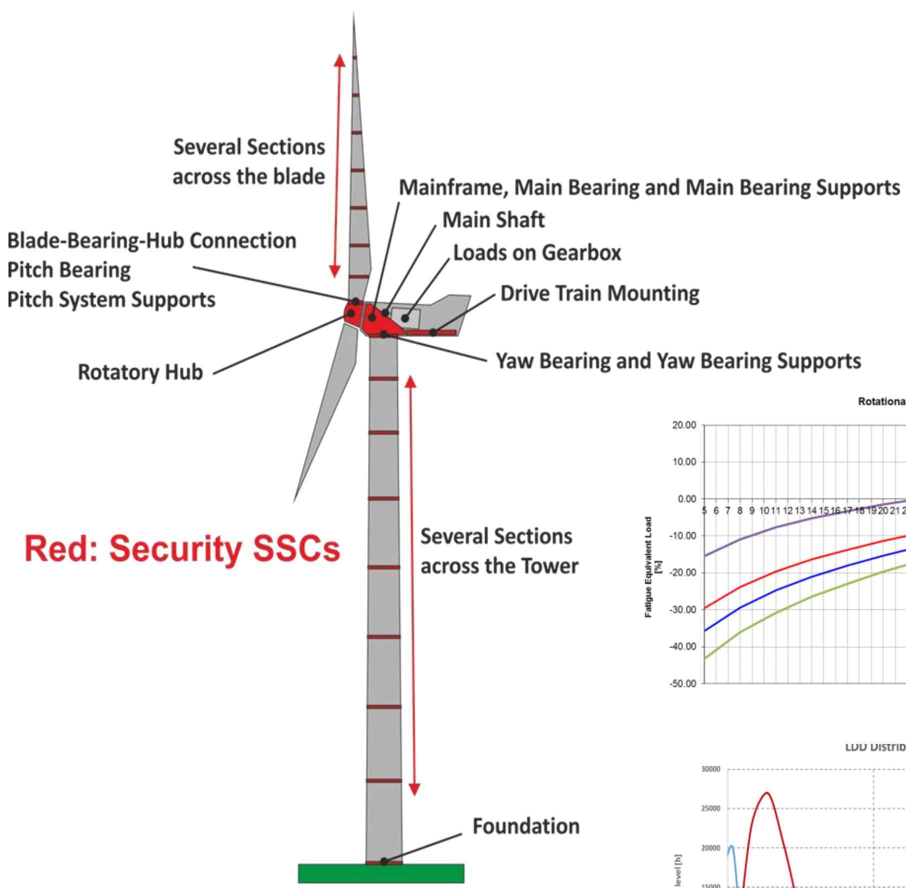
TURBINE REVERSEENGINEERING AND VALIDATION

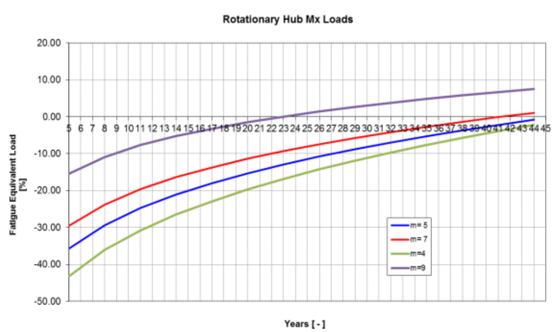


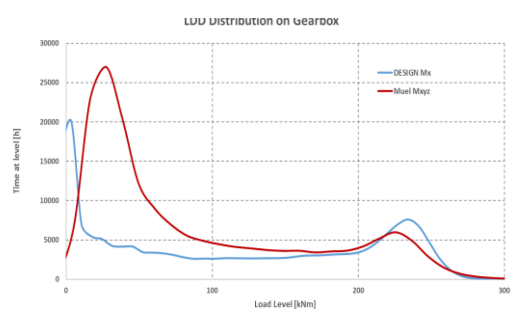




LIFE EXTENSION RESULTS







DESING LIFE REDEFINITION PER COMPONENT

COMPONENT	Site-Specific Design Life	
[-]	[years]	[%]
EXTENDER		
Extender-Hub Bolts	24	120
Section 0.9m	30	150
Section 2.4m	32	160
COMPOSITE BLADES		
COMPOSITE ROOT	32	160
Section R3.9	32	160
Section R6.9	37	185
Section R9.9	>40	200
Section R12.9	>40	200
Section R15.9	>40	200
Section R18.9	>40	200
Aerodynamic Brake	29	145
Section R20.4	37	185
Section R21.4	37	185
EXTENDER-BLADE BOLTS	24	120
HUB	>40	200
MAIN BEARING	>40	200
MAIN BEARING SUPPORTS	>40	200
MAIN FRAME	>40	200
MAIN SHAFT	23	115
GEARBOX	17	85
DRIVE TRAIN MOUNTING	23	115
YAW BEARING	>40	200
YAW BEARING SUPPORTS	>40	200
TOWER		
Section H4	>40	200
Section H8	>40	200
Section H12	>40	200
Section H16	>40	200
Section H20	>40	200
Section H26	>40	200
Section H32	>40	200
Section H38	>40	200
Section TOP	>40	200
FOUNDATION	>40	200

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