PROGRAM

SWTOMP PROJECT - WORKSHOP

Formation Center (AECID)
Spanish Embassy in Uruguay
Montevideo, October 10, 2019

INEEL
Instituto Nacional de Electricidad y Energías Limpias

"Technology optimization for SWT: generator and power electronics"

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Renewable Energies Department

Mexico

OUTLINE

- Calendar of WP3
- Operational scheme
- Aeroluz 5 kW wind turbine
- Optimization of the PMSG
- Analysis of an axial flux PMSG
- Power electronics

Calendar

TASK Number	Task Name	YEAR 1				YEAR 2				YEAR 3			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Task 3.1	Selection of SWTs to be optimised	OK											
Task 3.2	Redesing of the SWT	Tropical design											
task 3.3	Manufacture and installation of prototypes												
Task 3.4	Testing and Certification of SWT												
Task 3.5	Analysis of results												

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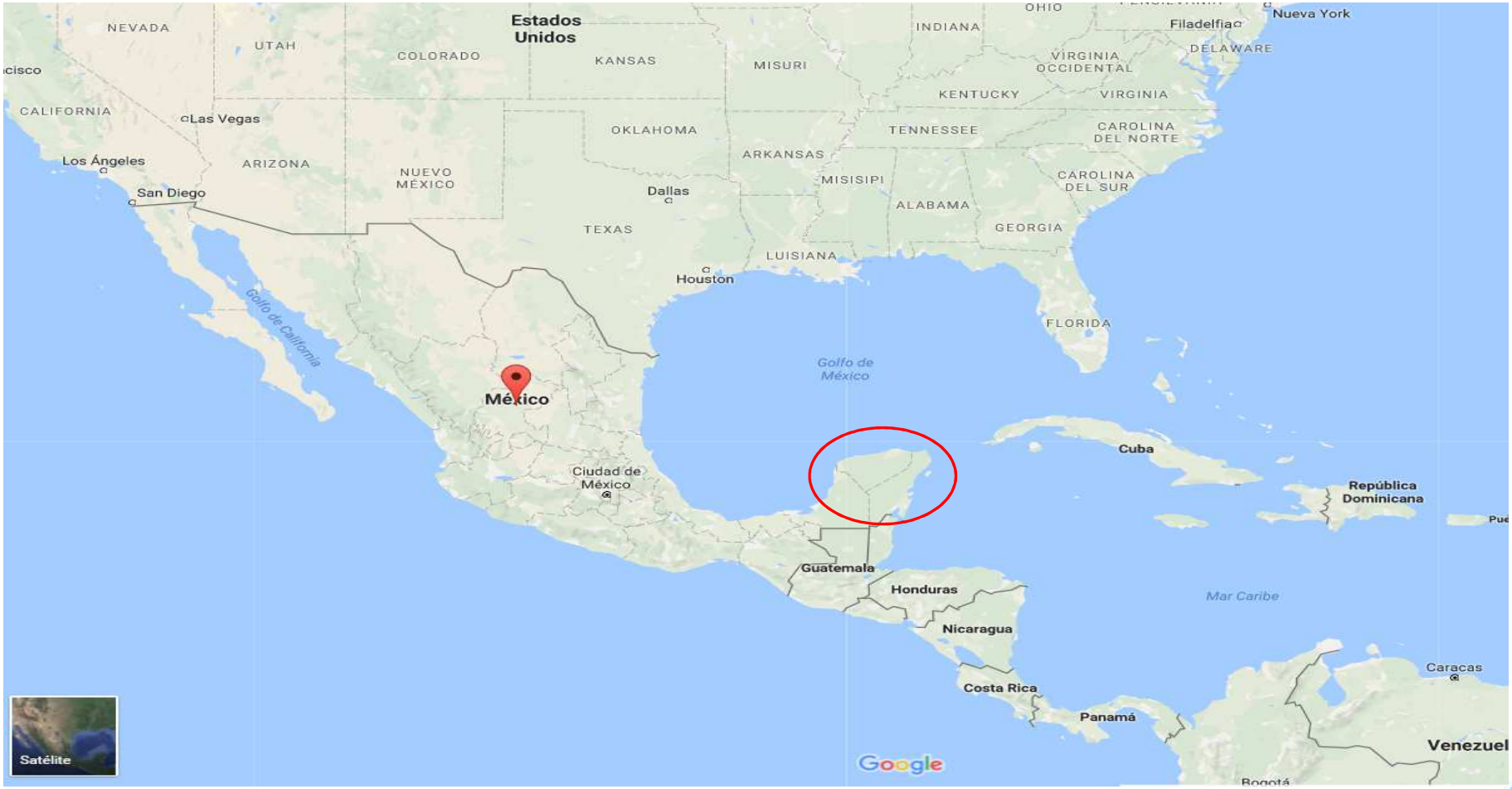
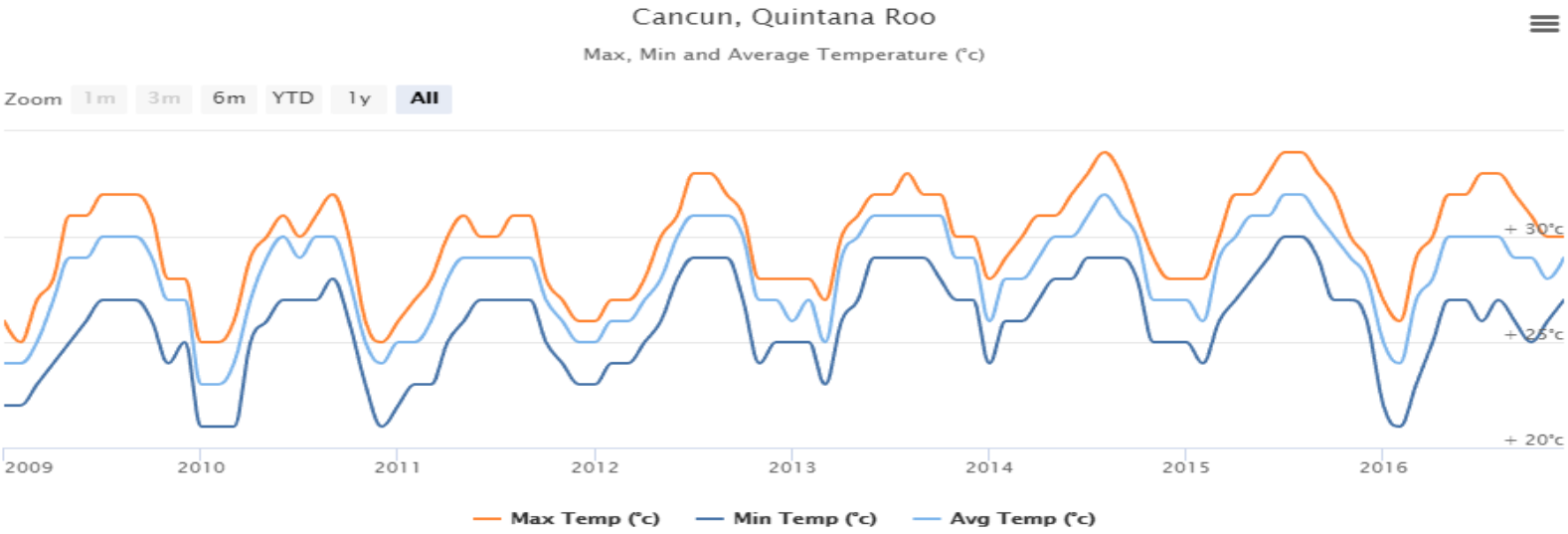
Tropical weather conditions

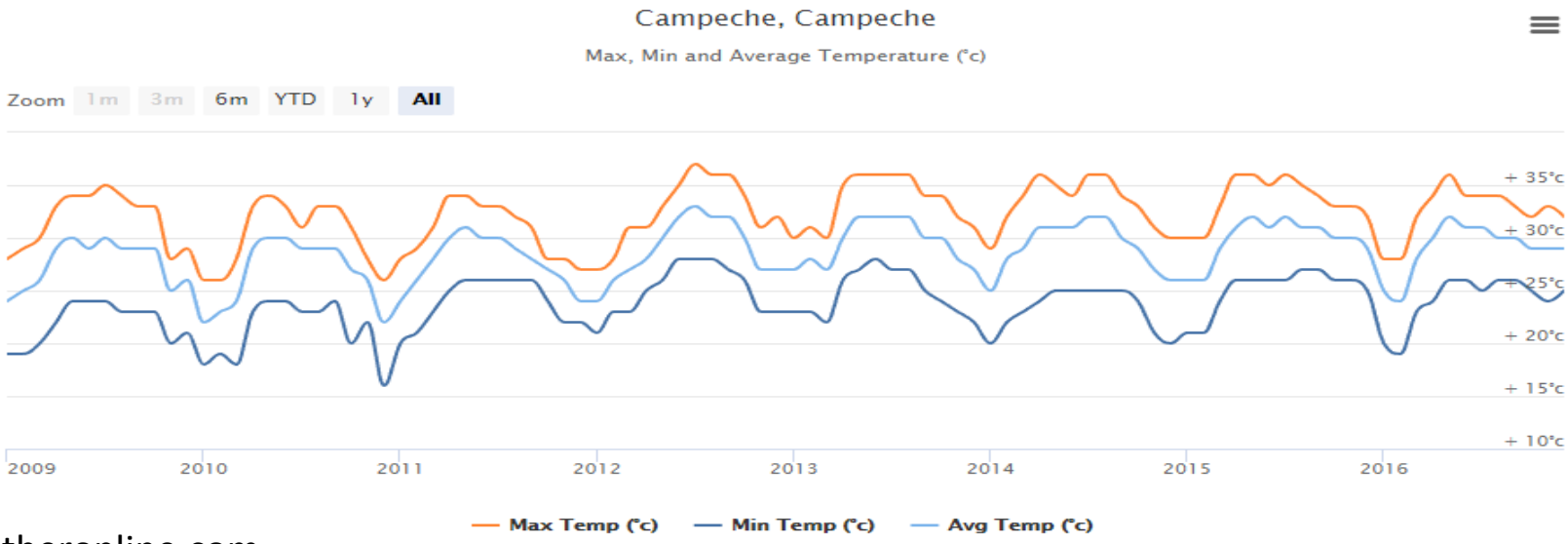
ropical zone



Weather conditions Caribbean (2009 – 2016)

verage temperature





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: https://es.worldweatheronline.com

Weather conditions Caribbean (2009 – 2016)

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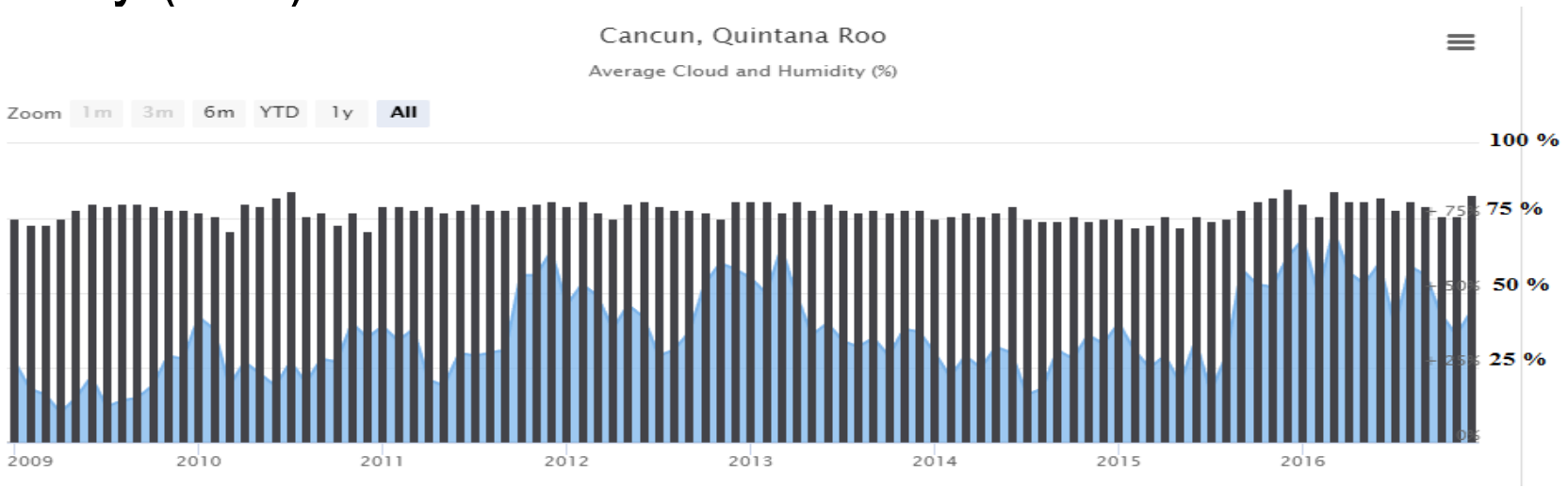
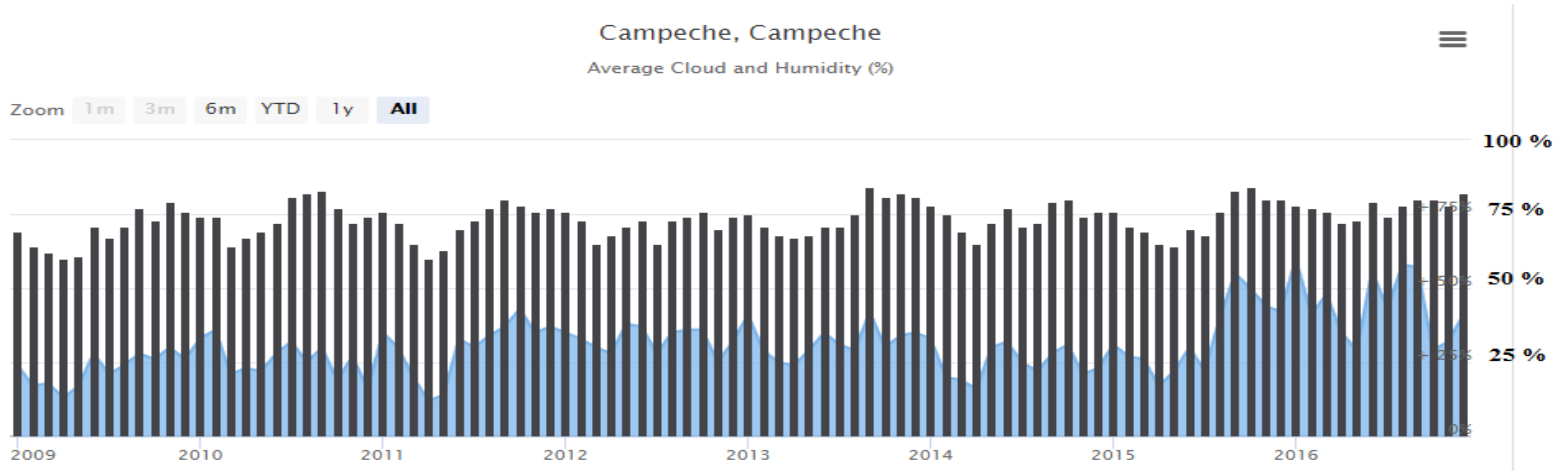
verage Humedity (bars)





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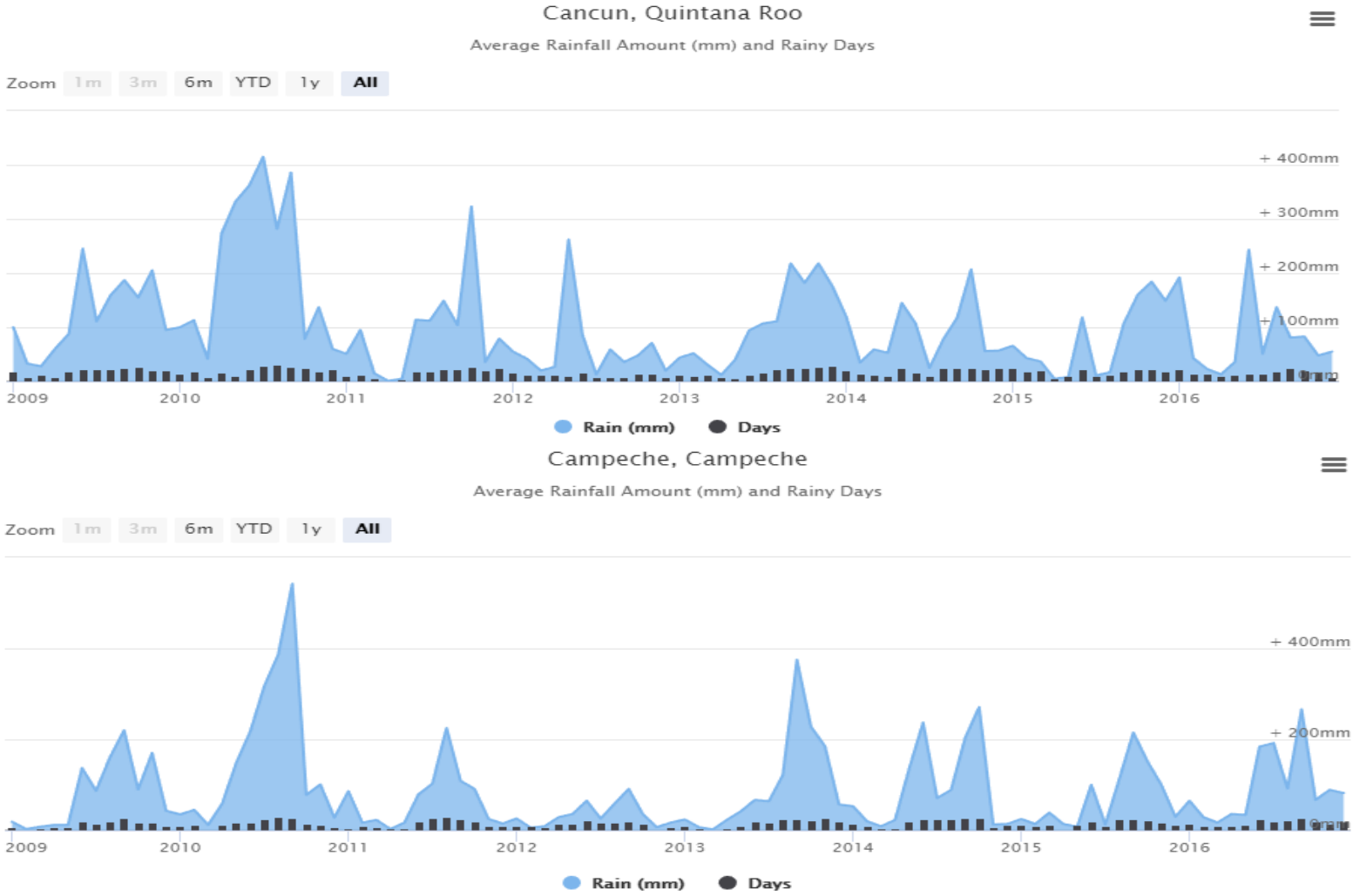
: https://es.worldweatheronline.com

Weather conditions Caribbean (2009 – 2016)

istorical rains



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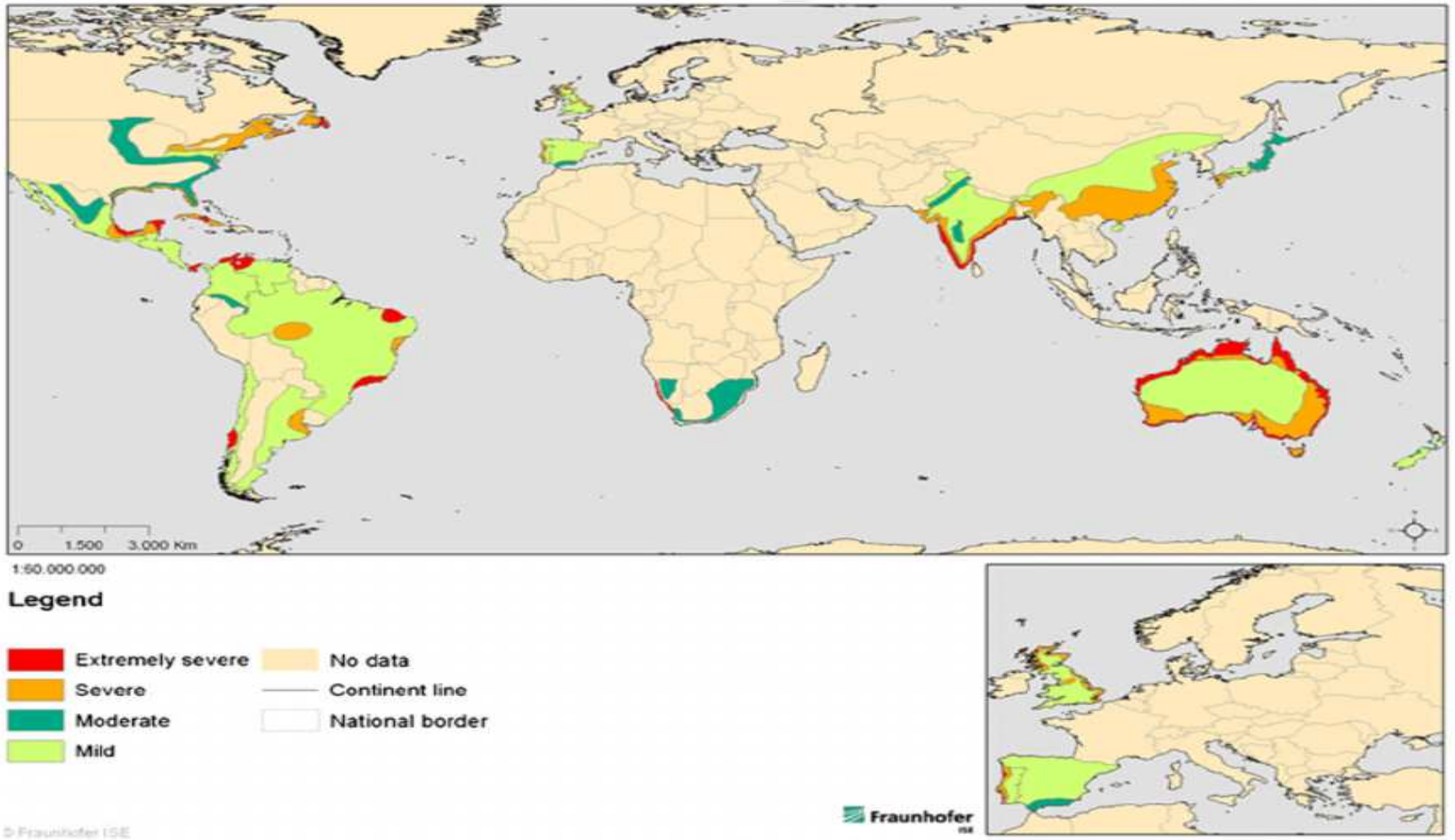
: https://es.worldweatheronline.com

Weather conditions

apping for atmospheric corrosion in coastal regions



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apping atmospheric corrosion in coastal regions:methods and results. Karolina Slamova, Rüdiger Glaser, Christian Schill, Stefan
eier and Michael Köhl. Journal for Photonics for Energy 2012

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Identification of opportunities

2.- Identification of opportunities (1st approach)

Cracks are generated on the rotor blades (rainy season).

Due to humidity and salinity, electronic cards of electric brake are failing. It produces mechanical stress in components.

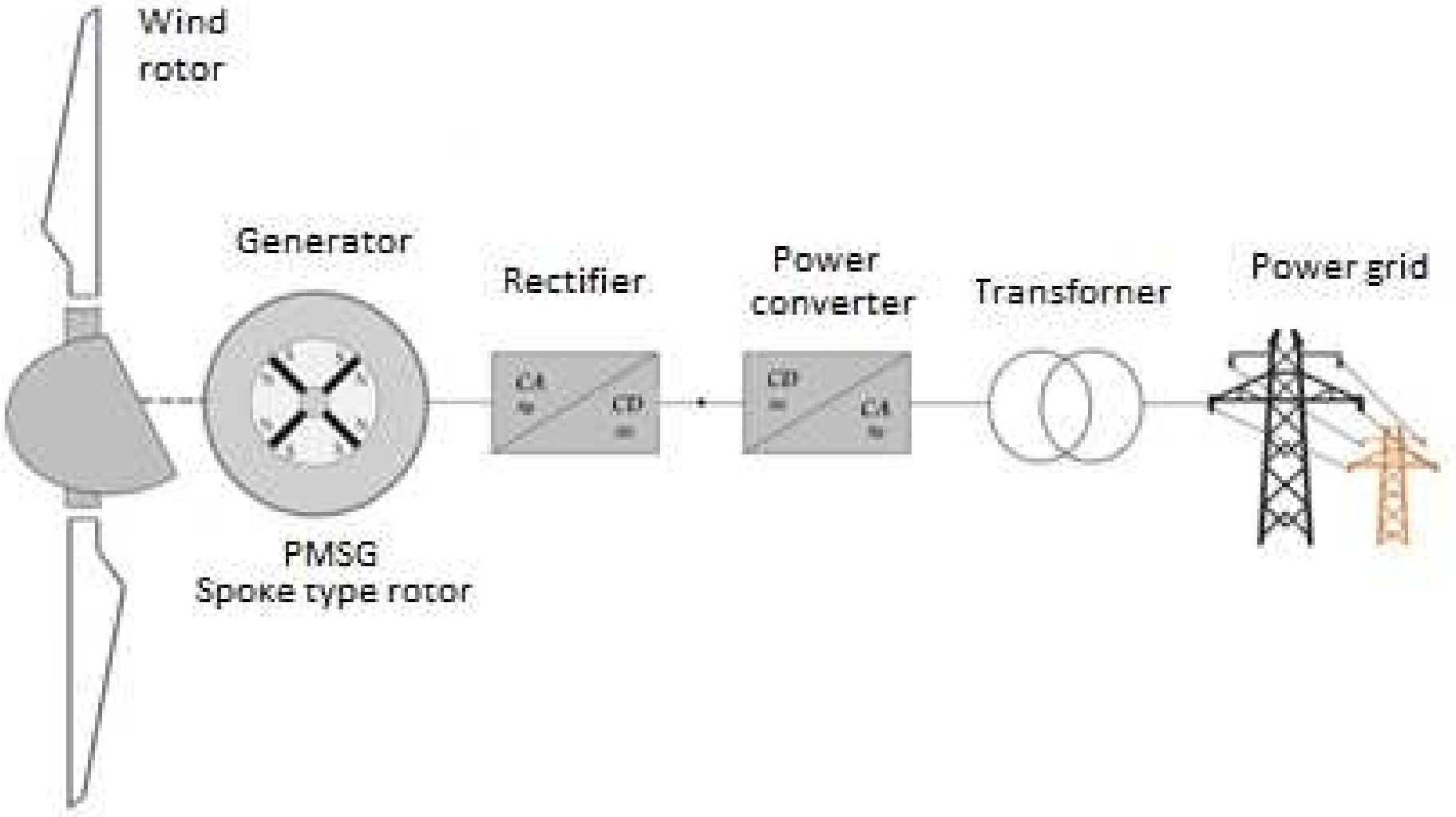
Epoxi on the magnets swells and brakes the machine.

The SWT must be painted every 1 or 2 years to be protected of weather conditions

Failure in mechanical welding

Operational scheme

Operational scheme



Aeroluz 5 kW wind turbine

Aeroluz 5 kW wind turbine

- Tower:
  - 18 meters
  - 3 sections
  - Galvanized steel

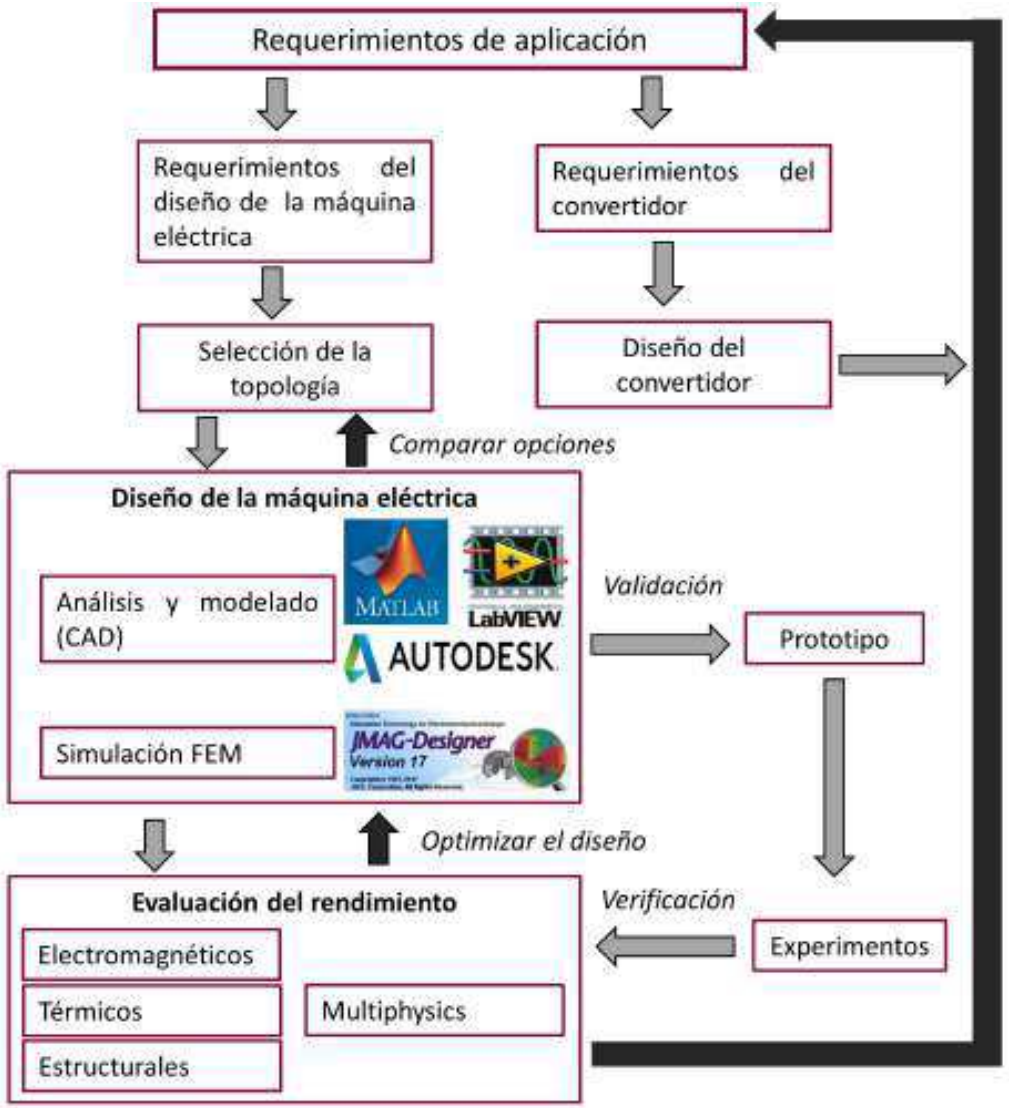
- Grid Inverter (6kW)
  - Range input operating: 50-580 V
  - Max. Input Current 36 A
  - Input voltage at full power: 200-580
  - Max. Continuous output power: 6000W@ 50°C
  - Frequency range: 59.3-60.5 Hz
  - Power factor: >0.995
  - Nominal output voltage: 277 V / 240 V / 208 V

Optimization of the PMSG

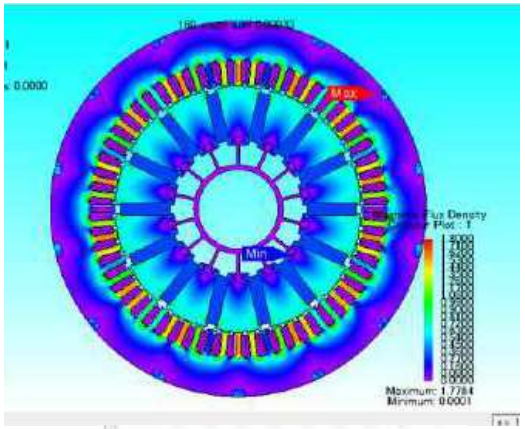
Optimization of the PMSG

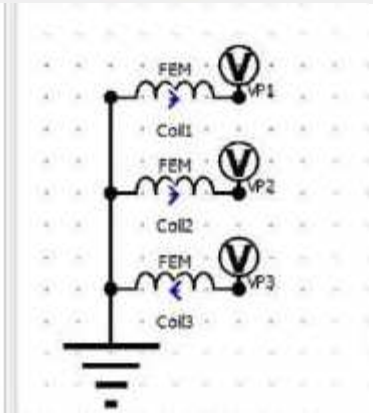
Electric parameters and performance			
Nominal Power	5 kW	Efficiency	5 kW power: • Nema Premium efficiency > 86%. • IEC 60034-30-1: > 84.5%
Speed range	180-220 rpm	Nominal speed	200 rpm
Voltage per phase	155 V	THD_V	Norma IEEE-519-2014: ≤ 5% individuals harmonic distortion. ANSY/NEMA MG 1-2009: ≤ 5%, line to line vo
Frequency	Por definir (De acuerdo a la combinación de números de polos y ranuras, para una correcta distribución de devanado)	Current density	4 - 6 A/mm^2
Cogging torque and torque ripple	Valor bajo	TRV	7 - 14 kNm/m^3
Number of phases	3	Winding connections	Star
Geometrical constraints			
Outer radio of stator	0.1915 m	**Stator inner radiio R_{si}**	0.126 mm
Stacking length	0.178 m	**Airgap**	1 mm of non uniform
Outer radio of the rotor R_{ro}	0.125 m (parámetro variable, de acuerdo al entrehierro definido)	**Number of tooth (N_s)**	60
Filling factor (K_{cp})	40% a 60%	**Stacking factor (K_{st})**	90%
Tooth factor (α_s), ≤ 50%	25%	**Deep of tooth fraction (α_{sd}) (25% - 50%)**	45%
Flux density			
Stator core B_{cs}	1.6 T	**Stator tooth B_{ts}**	1.8 T
Rotor core B_{cr}	1.7 T		
Materials			
Electrical steel	M19	**Magnet type**	Ferrite
Conductors material	Copper		

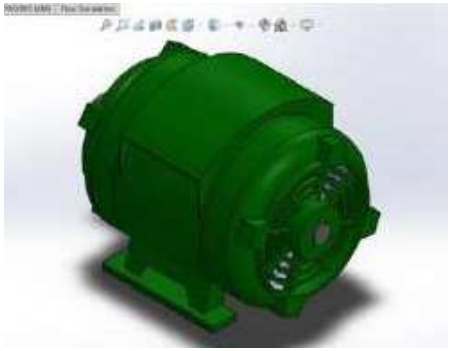
Design process

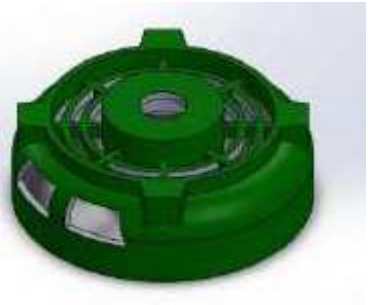


5 kW PMSG

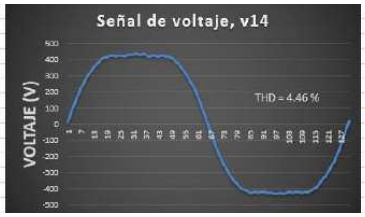

Max
Min
Flux Density
Plot : 1
Maximum: 1.7784
Minimum: 0.0001


FEM
VP1
Coil1
FEM
VP2
Coil2
FEM
VP3
Coil3

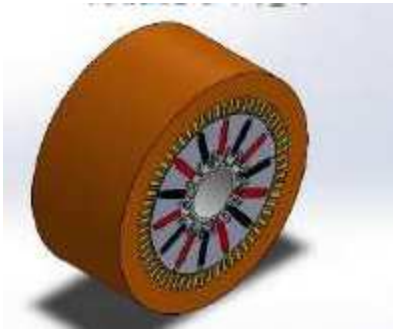


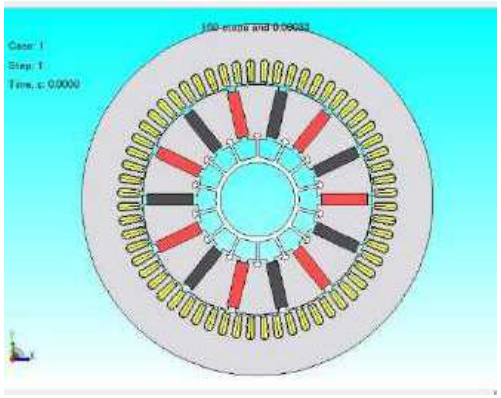



Señal de voltaje, v13
THD= 1.14 %


Señal de voltaje, v14
VOLTAJE (V)
THD = 4.46 %

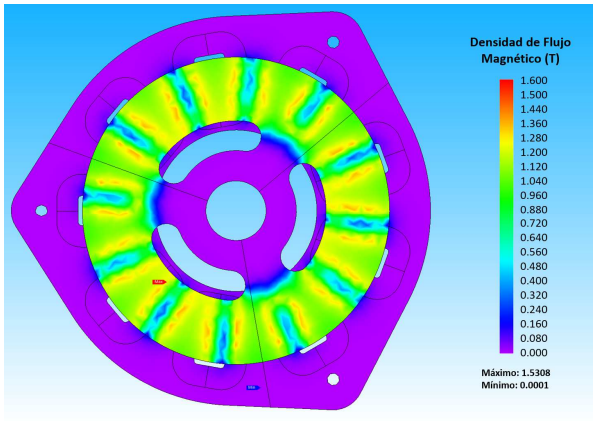

Señal de voltaje, v15
-VOLTAJE (V)
THD=3.62 %

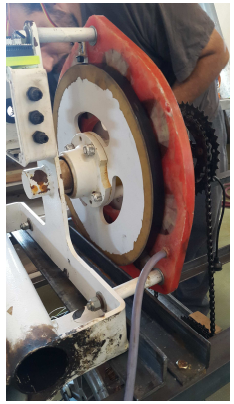


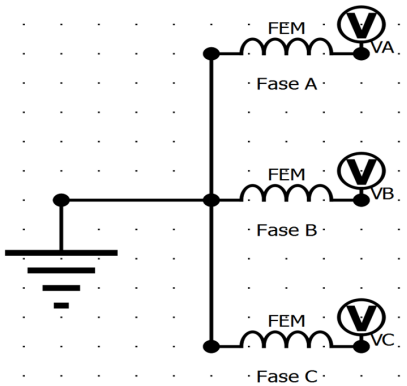


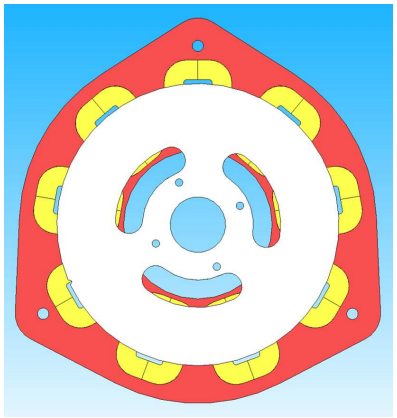
Analysis of an axial flux PMSG

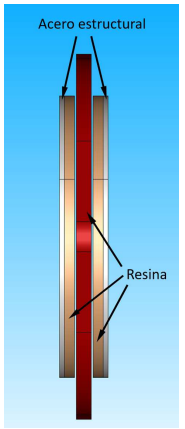
Axial flux machine. 600 W. (Collaboration with INTI)

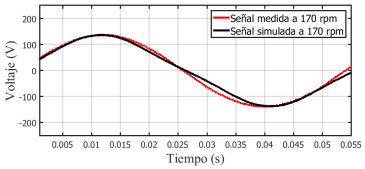


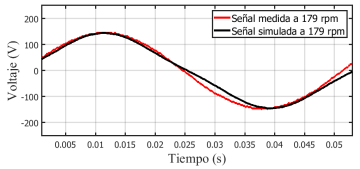


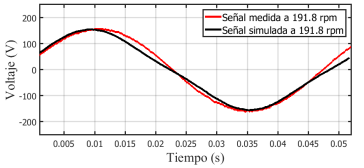


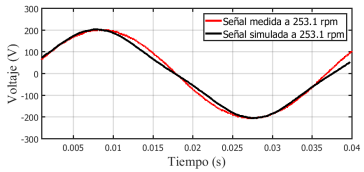


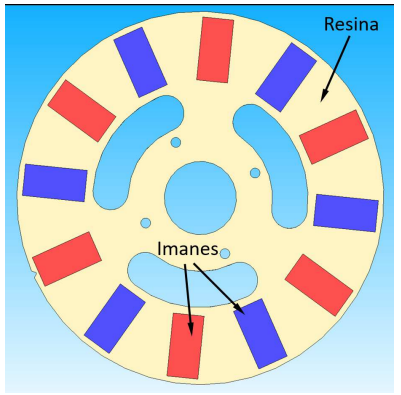


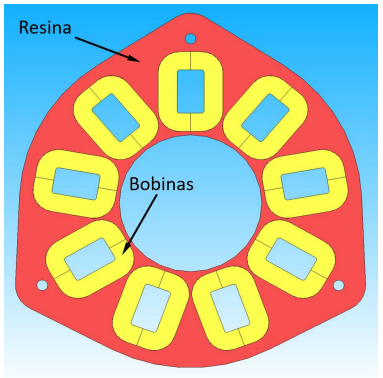












Power electronics

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Thanks

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