



# **Manef BOUROGAOUI**

**Fulbright Visiting Scholar**

**January 01 to December 31 - 2020**



**BUREAU OF EDUCATIONAL  
AND CULTURAL AFFAIRS**



**INSTITUTE OF  
INTERNATIONAL  
EDUCATION**



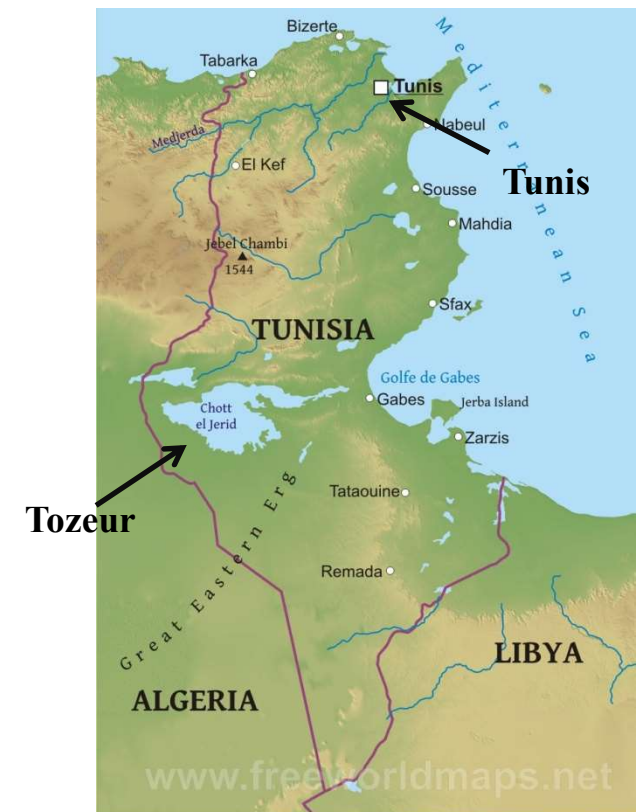
**Arlington, VA, USA, January 13 - 2020**

# About me

## Country geographic position



## Tunisia



Tozeur



# Education and Appointments

## Education

**Ph.D**, Electrical Engineering, in 2014

Ecole Nationale d'Ingénieurs de Tunis (ENIT), **National Engineering School of Tunis**

Université de Tunis el Manar, **Univeristy of Tunis el Manar**

Title of Dissertation: “PMSM Sensorless Fault Tolerant Control under Position Sensor Faults”

## Appointements

### Assistant Professor

National Engineering School of Carthage, **Tunis**

National Engineering School of **Gafsa**

High Institute of Information Technologies and Communication, **Tunis**

### Permanent Researcher

National Engineering School of Tunis, **Tunis**



# Education and Appointments

## Teaching



# Education and Appointments

## Research



# My research team in Tunisia

## Research



<http://www.lse-qehna.tn/en/home/>



# Some Synergistic Activities

## Member in several research projects:

PEER (Partnerships for Enhanced Engagement in Research), Project funded by the U.S. Agency for International Development (USAID), 2018-2020  
Partnership with Missouri University of Science and Technology,  
“Impact of rooftop PV system integration on Tunisian electrical distribution network”

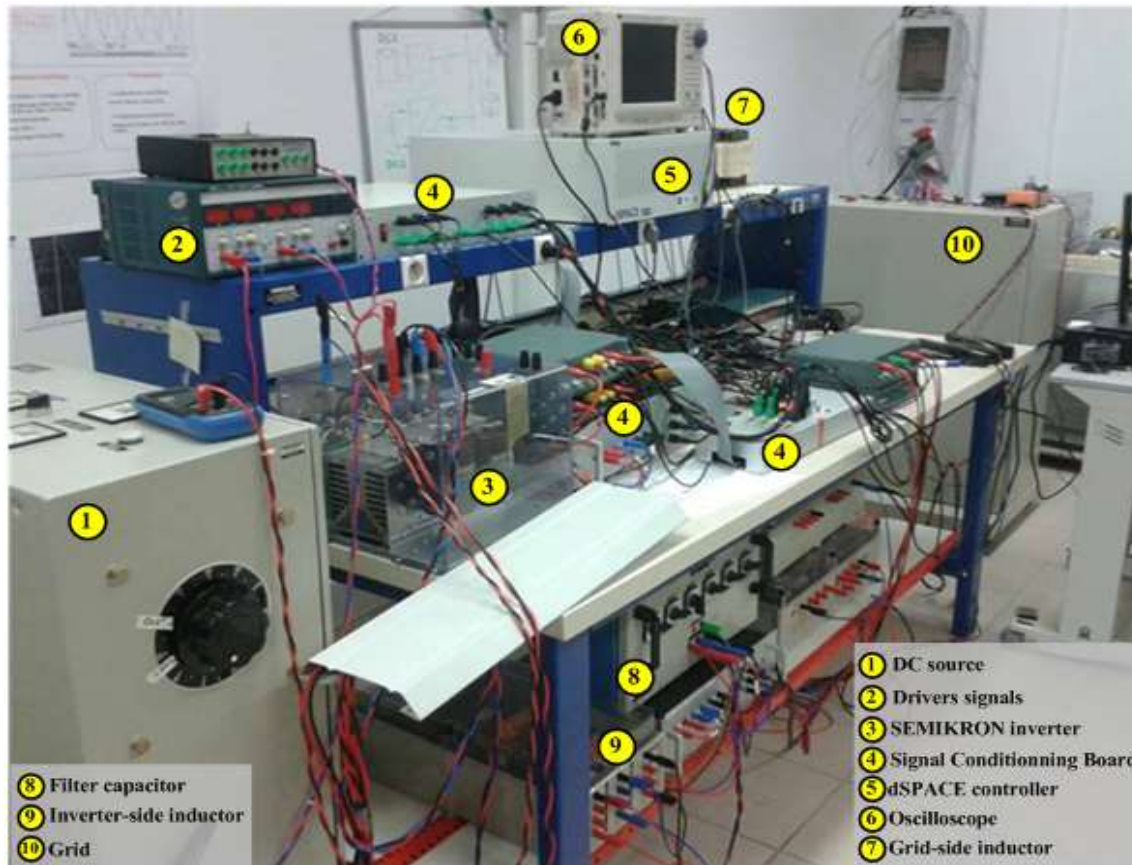
PAQ-Collabora, Project funded by the Ministry of higher education and scientific research, Tunisia, 2019-2022  
Partnership with several companies.  
“Development of smart e-monitoring system of PV energy generators with high marketability”

PAQ-Collabora, Project funded by the Ministry of higher education and scientific research, Tunisia, 2019-2022  
Partnership with several companies.  
“A Platform for investigation and integration of new energy technologies into an electrical distribution network”



# Collaboration

- ❖ Some experiments have been performed under a collaboration with IREENA laboratory, Saint-Nazaire, France.



- ➔ Implementation of a signal processing algorithm for resonance frequencies monitoring





# My fellowship program

## Summary

First contact with Professor Saifur Rahman: August 2018 at National Engineering School of Tunis (ENIT)

Presentation about IEEE-PES

Presentation about IoT and monitoring in buildings



### Project title:

PV system integration  
and monitoring in buildings



**Date of application:** May 2018

Project was accepted by Fulbright commission in USA in December 2018

Project started in January 01- 2020 for one year.



# My fellowship program

## About Fulbright



### About...



Senator James William Fulbright  
ARKANSAS

- 1946: Created by U.S. Congress
- Over 8,000 grantees from 155 countries annually
- Administered overseas by bi-national Fulbright Commissions and U.S. Embassies

### Goal

*To increase **mutual understanding** between people of the U.S. and people of other countries through exchange*

For more information, visit:

<http://eca.state.gov/fulbright>



# My fellowship program

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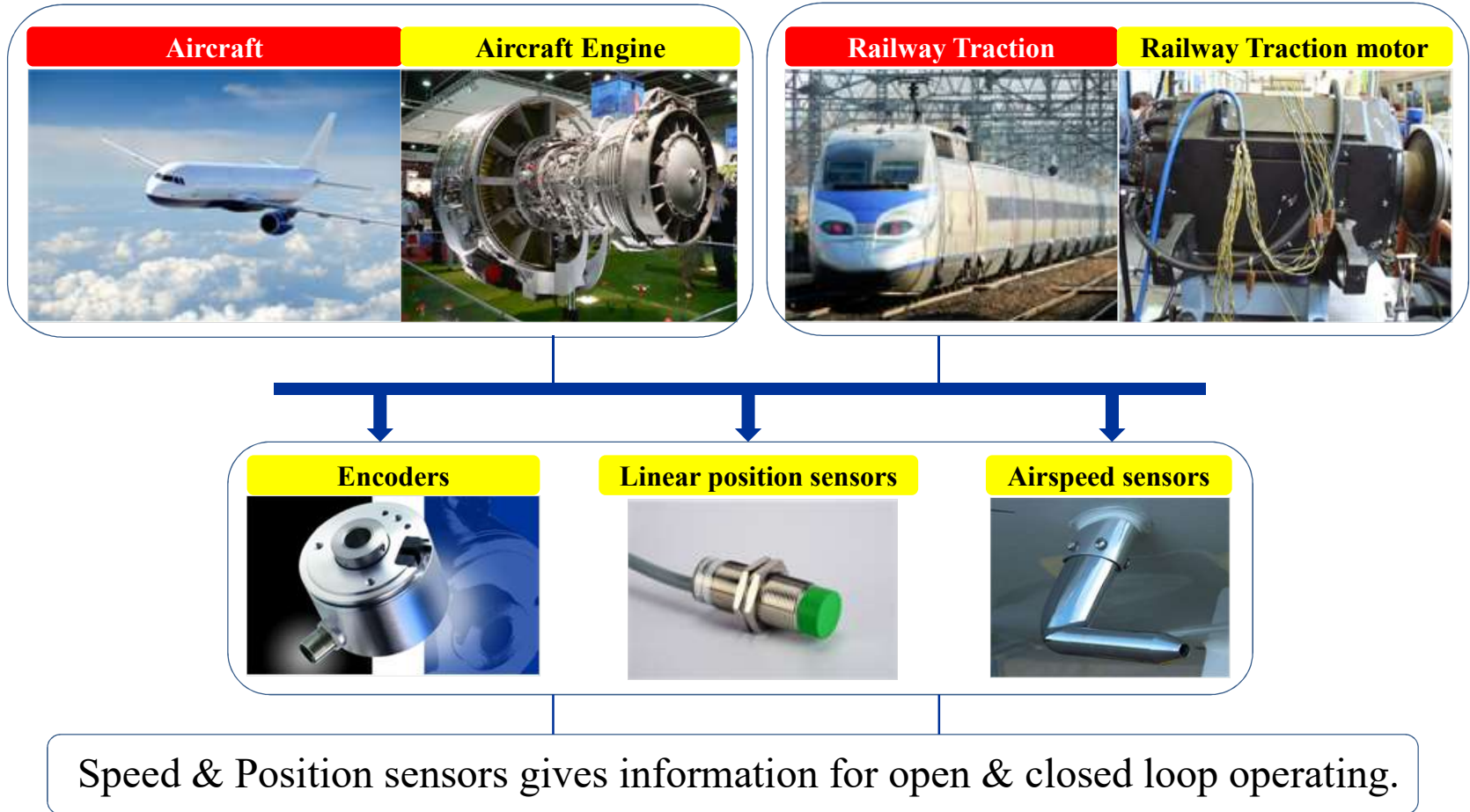
## Goals

- Participate in ARI activities.
- Learn from ARI experiences, especially in IoT, monitoring and Blockchain.
- Discover more software and tools used for simulation in Microgrid applications.
- Find Possible collaborations between ARI and Qehna research team in Tunisia.
- Improve my English.



# Past Research works: PhD

## Speed & Position Sensors in Electrical Systems



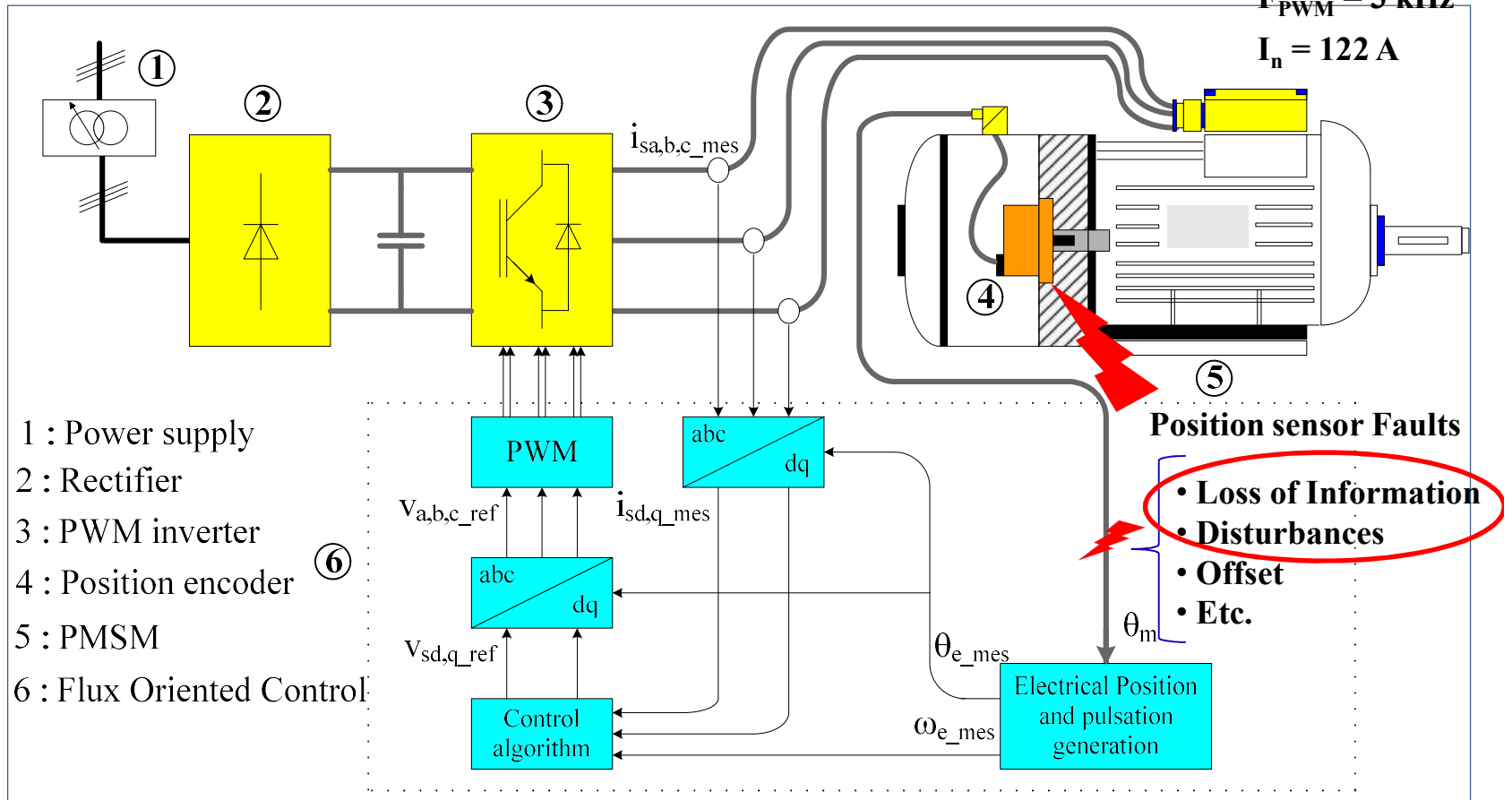
# Past Research works: PhD

PMSM Flux Oriented Control scheme with position sensor

$P_n = 53 \text{ kW}$

$F_{\text{PWM}} = 3 \text{ kHz}$

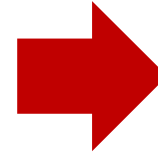
$I_n = 122 \text{ A}$



- **Fast detection** → **Avoid the hard failure of the PMSM**
- **PMSM drive reconfiguration at low and very low speeds using HFSI.**

# Actual Research works

## Problem of energy integration into the grid



Despite the solar energy advantages, this development is causing problems in term of energy integration into the electric grid.



Technical solutions for an holistic energy integration into the grid ??

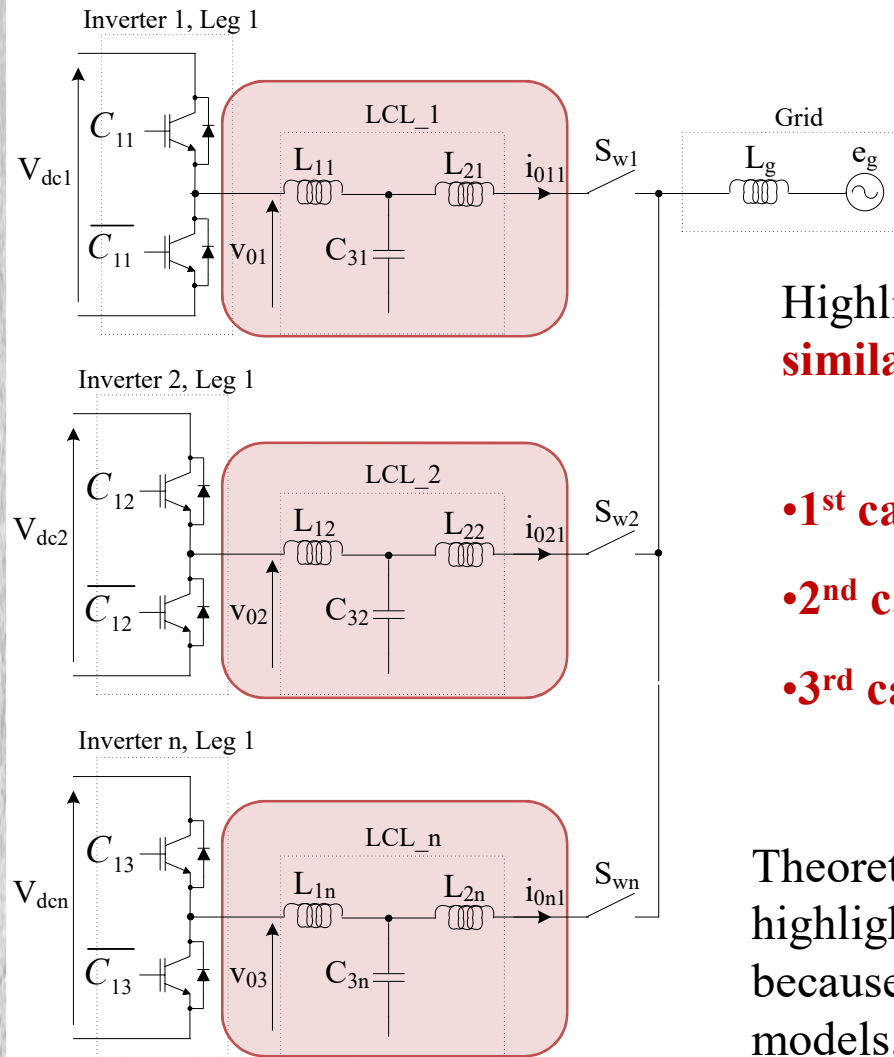


**In this Research Works**

- Problem of solar energy integration onto the grid through Micro-Grid (MG) concept,
- Take into account the instability phenomena that may appear because of the use of LCL filters.

# Actual Research works

## Microgrid Scheme



### In this Research Works

Highlight the difference between a MG with **similar** and **different** LCL filters.

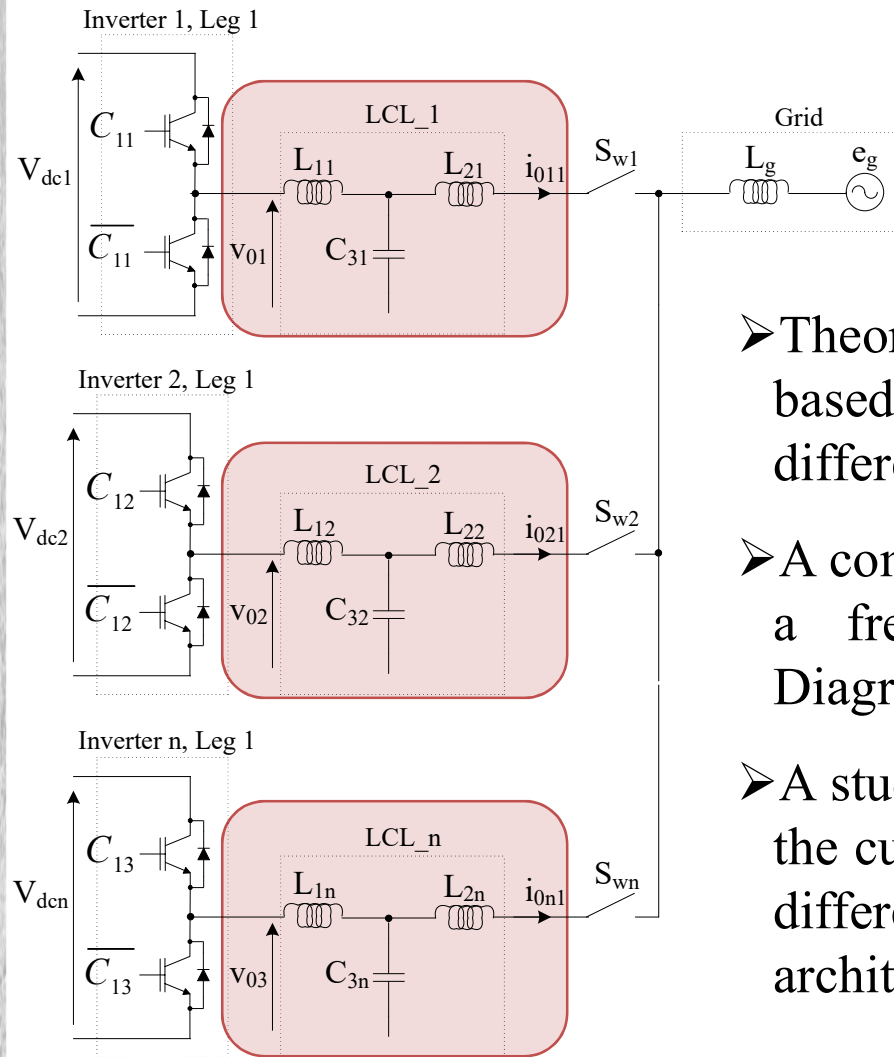
- **1<sup>st</sup> case:** a MG with  $n$  similar LCL filters,
- **2<sup>nd</sup> case:** a MG with 2 different LCL filters,
- **3<sup>rd</sup> case:** A MG with 3 different LCL filters.



Theoretical development was given in order to highlight the complexity of such architecture because of the non linearity of mathematical models.

# Actual Research works

## Proposed Microgrid Scheme



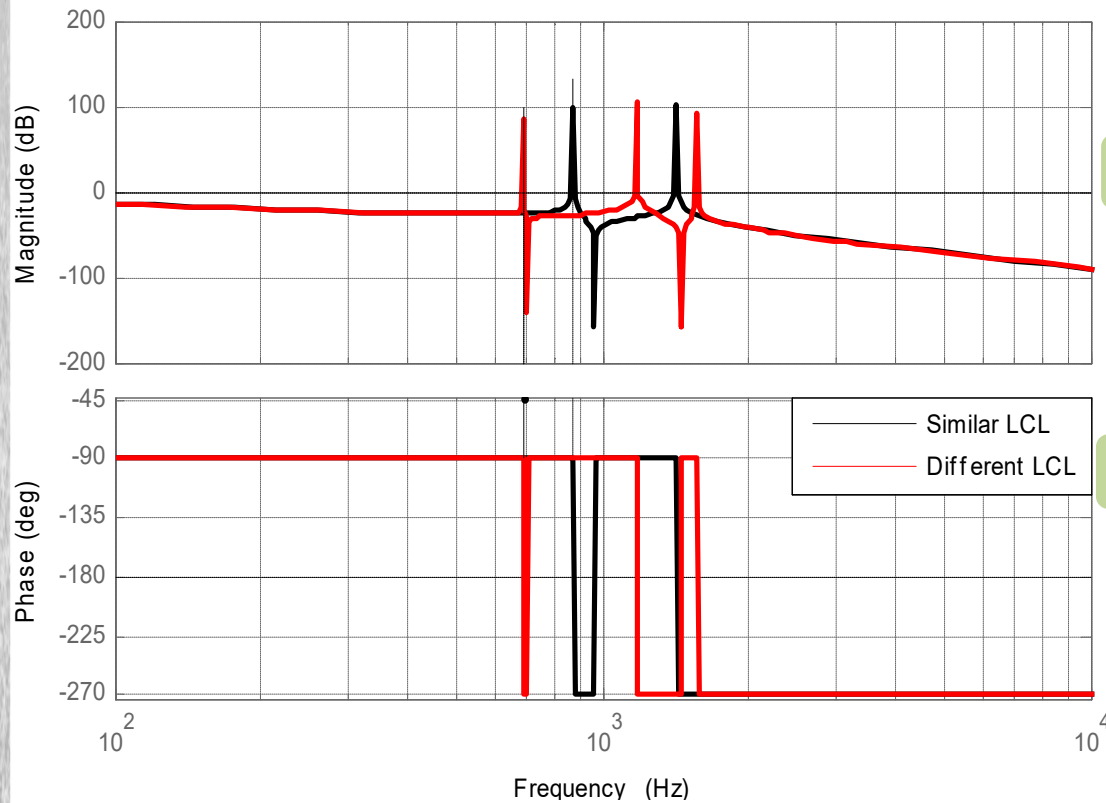
**In this Research Works**

- Theoretical development of a given MG based on two and three LCL filters with different parameters,
- A comparison study was given basing on a frequency analysis through Bode Diagram,
- A study, from electrical point of view, of the currents waveforms related to a three different LCL filters based-MG architecture.



# Actual Research works

## Bode Diagrams



Three **Similar** LCL filters

$$G_{11}(p) = H(p)T(p)$$

Three **different** LCL filters

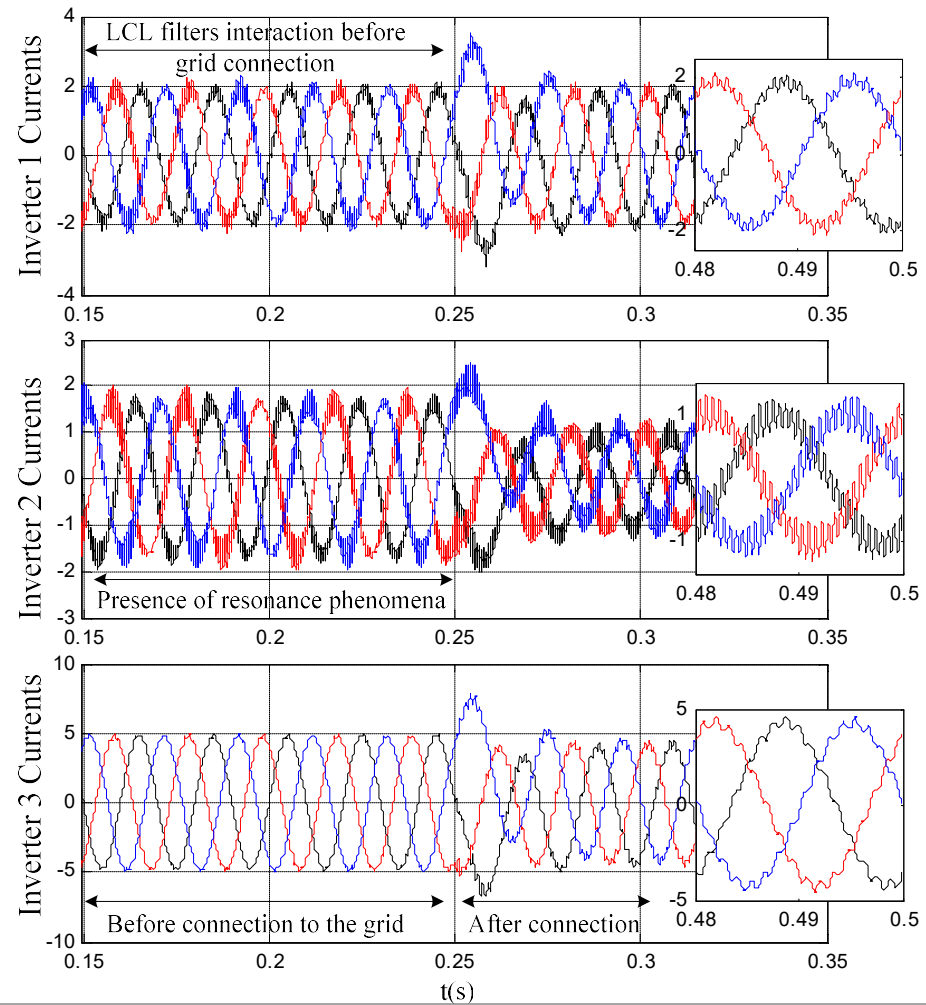
$$G_{11}(p) = \frac{1}{\frac{1}{H_1(p)} + \frac{T(p)}{H_2(p) \cdot H_3(p)}}$$

- For a MG with three different LCL filters, **five peaks appear**, because of resonance phenomena, instead of three in the case of three similar LCL filters.
- The MG complexity increases by the presence of two additional frequencies in  $G_{11}$  because of the coupling effect between the three filters.

# Actual Research works

## Interactive resonant phenomena through currents analysis

### Three parallel LCL filters connected to the grid



# Actual Research works

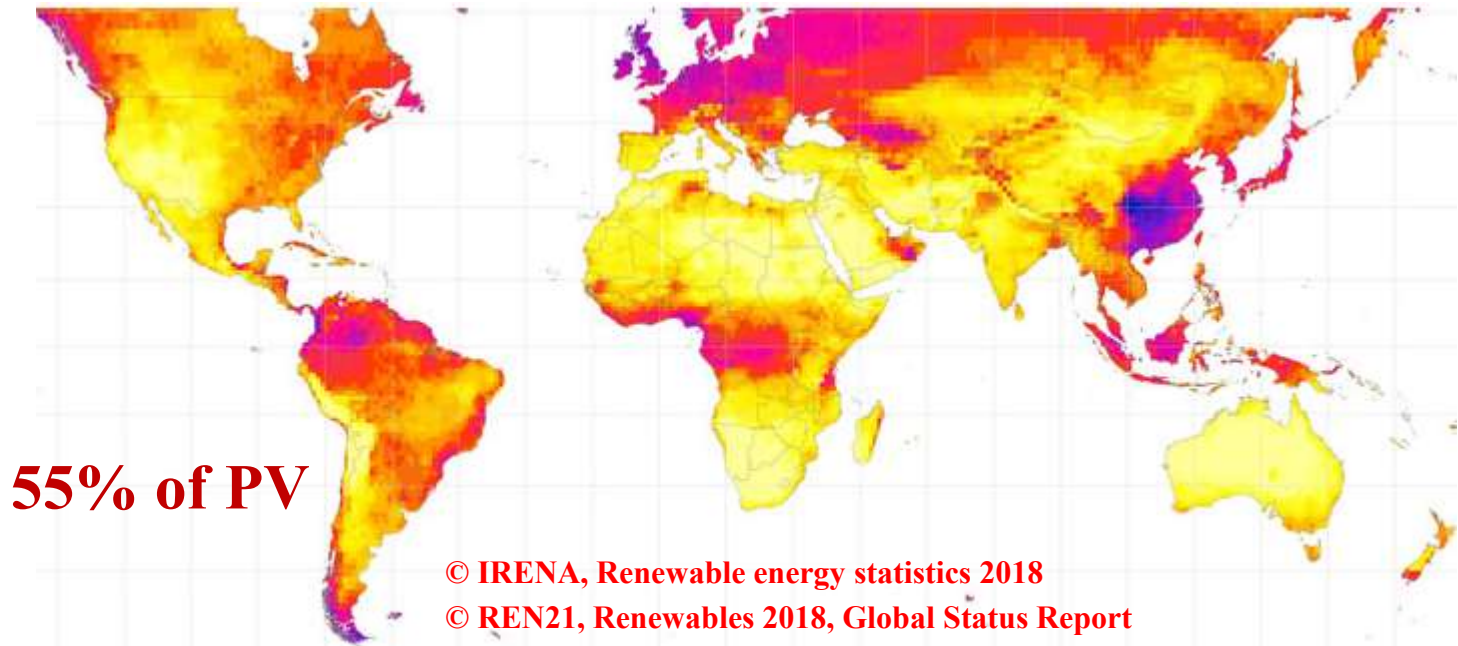
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## Summary

- ❖ Investigation about the complexity of parallel grid-connected inverters,
- ❖ Modeling of a microgrid in the case of similar LCL filters,
- ❖ Modeling of a microgrid with different LCL filters parameters,
- ❖ Bode diagram analysis in order to highlight coupling effect and interactions between the different connected LCL filters,
- ❖ Currents waveforms analysis to highlight the MG behavior in the presence of resonance-phenomena.
- ❖ Results demonstrated the complexity issue when dealing with more than two LCL filters with different parameters.
- ❖ Monitoring of resonance frequencies in a microgrid.

# About Tunisia

## Photovoltaic energy consumption in the world



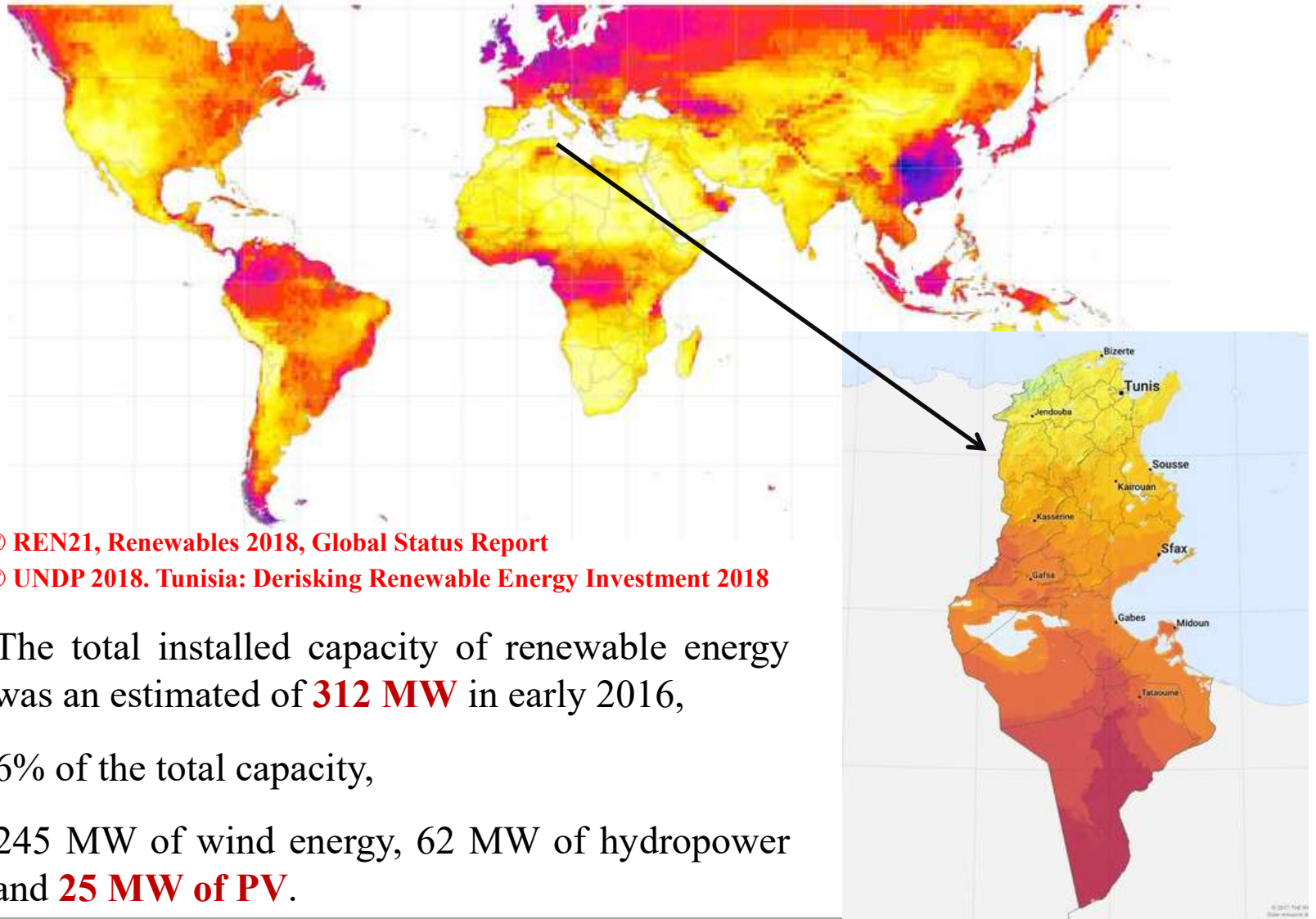
### More solar PV capacity



- The photovoltaic solar market grew by **25%** between 2014 and 2015, reaching a power record level of 50GW.
- In 2015, the annual market was ten times higher than the total produced energy through the last ten years.
- Solar PV accounted for nearly **55%** of newly installed renewable power capacity in 2017.

# About Tunisia

## Tunisia case: Actual installed renewable energy



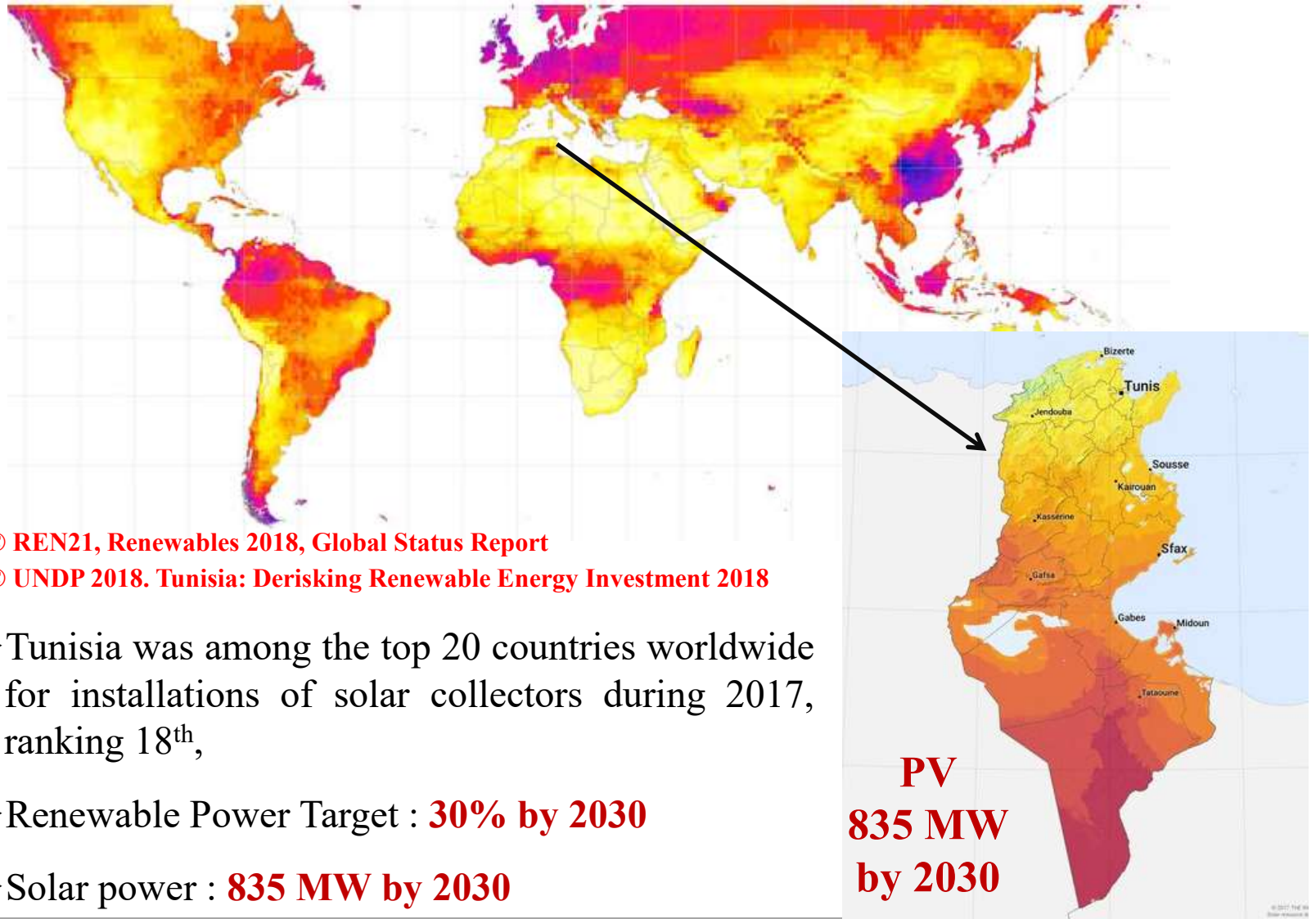
© REN21, Renewables 2018, Global Status Report

© UNDP 2018. Tunisia: Derisking Renewable Energy Investment 2018

- The total installed capacity of renewable energy was an estimated of **312 MW** in early 2016,
- 6% of the total capacity,
- 245 MW of wind energy, 62 MW of hydropower and **25 MW of PV**.

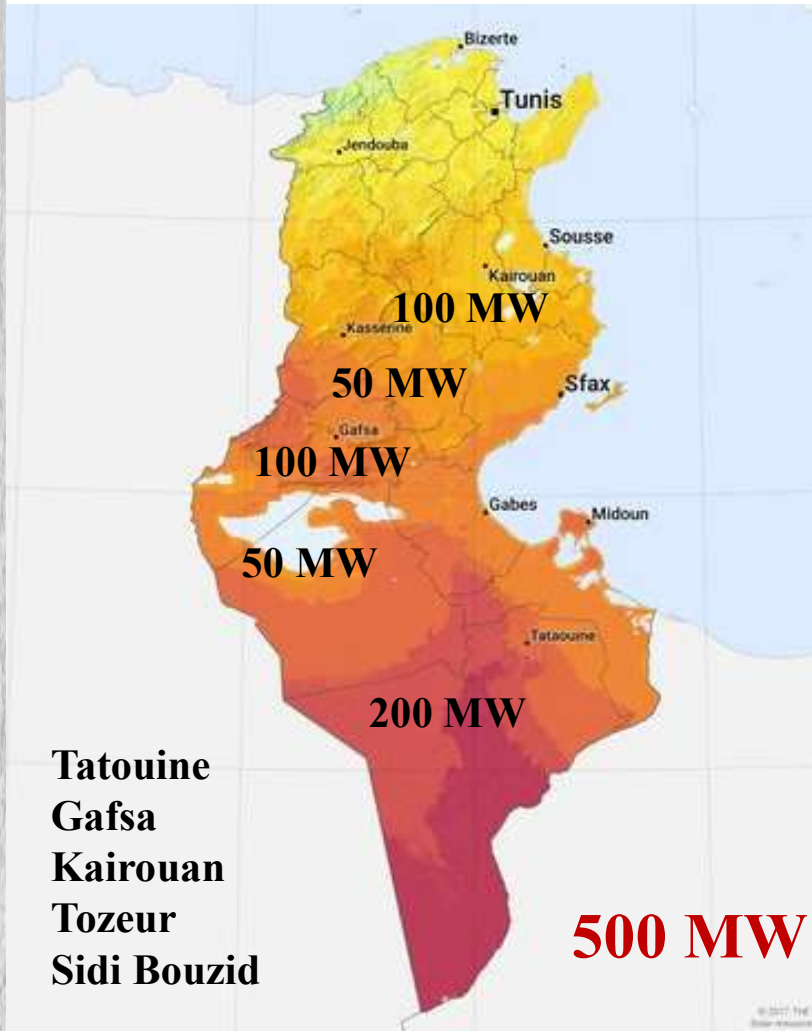
# About Tunisia

## Tunisia case : Targets



# About Tunisia

## Tunisia case : Solar PV Projects



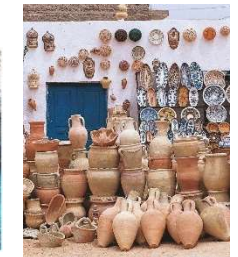
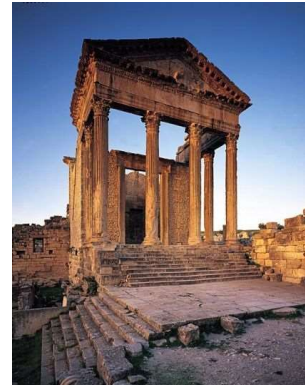
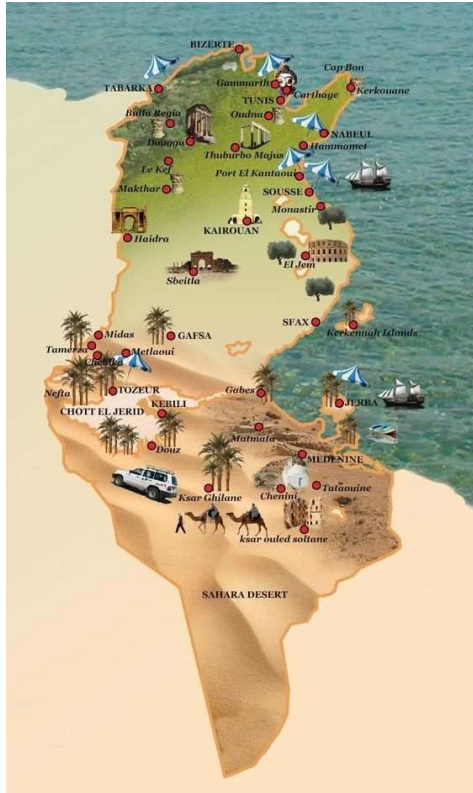
© Electrek Green Energy Brief, May 2018

In 2018, Tunisian government opened bidding for 5 new plants using photovoltaic.



## Tunisian Solar Plan (TSP)

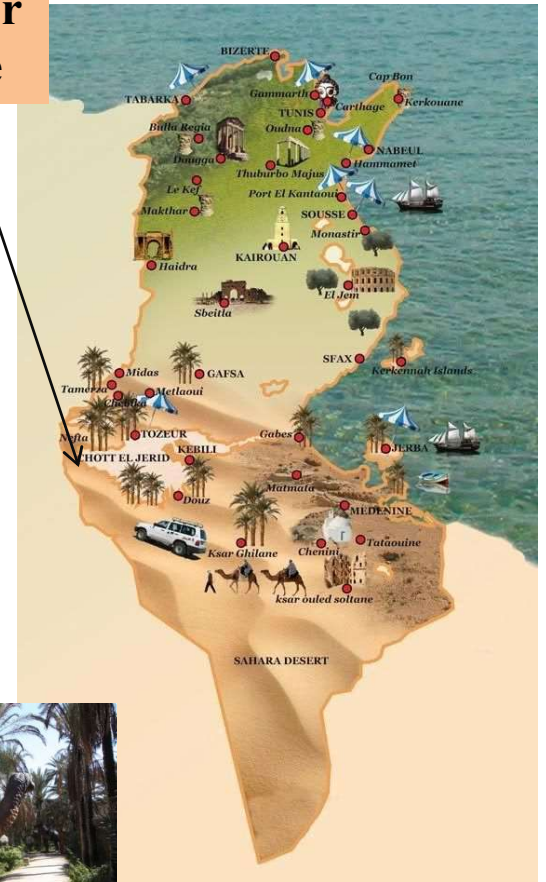
# Visit Tunisia





# Visit Tunisia

Tozeur State



FULBRIGHT



THANK YOU  
FOR YOUR ATTENTION



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