Co-funded by the
Erasmus+ Programme
of the European Union

Project: Wind Engineering Skills in Egypt and Tunisia (WESET)
Project Number: 586039-EPP-1-2017-1-ES-EPPKA2-CBHE-JP

WIND ENGINEERING CENTRE (WEC) LABORATORY SETUP SUPPORTED BY WESET PROJECT

1. Background

The developed Wind Energy Center (WEC) equiped with infrastructures that are funded by WESET project. Erasmus+ Project WESET has started initially in October 2017 and was established officially in 2018 to address the needs of capacity building in the Wind Energy in Egypt and Tunisia. The project transfers knowledge and technology between experts in EU, Egyptian and Tunisian institutions in the field of Wind Engineering.

The AASTMT-WEC hosts a laboratory and a training facility for undergraduates, graduates and professional engineers interested in the Wind Energy field. The AASTMT-WEC is integrated with an already exciting renewable energy lab located in room G501, building G, Faculty of Engineering and Technology, AASTMT, Alexandria campus which was supported by JAMLIA TEMPUS project (2015-2017). The supported WESET equipment for WEC focuses on the Electrical part of wind Energy, the mechanical parts of wind energy are located in other WEC's in ASU and BUE that will be continuing used by AASTMT WEC through the signed agreements among the Egyptian WEC's. Additional computer lab and automation setup for wind energy simulation and control are also bought and located in another lab in faculty of engineering room next door to G501.

2. AASTMT WEC Equipment's

The AASTMT WEC equipment is located in renewable energy lab in AASTMT. The renewable energy lab overview is shown in Figure below. The lab is equipped by different setups related to renewable energy, such as 50 KW Photovoltaic (PV), solar emulator and heater, biofuel process, electric hybrid vehicles, wind energy setup, etc….

The added wind energy components are integrated with the existing systems. The description of the WEC components will be described in this section.

Figure 1 Renewable Energy Lab Overview

2.1 **Real-Time Digital OP5600 SIMULATOR**

- The OP5600 Real-Time Simulator (RTS) is the most adopted simulation platform by OPAL-RT's users in industry and academia.
- OP5600 combines the performance, versatility and reliability that is ideal for demanding hardware in the loop applications.
- It can be applied in the power systems, aerospace, automotive, oil and gas or other electro-mechanical industries, the OP5600 has the power to simulate systems, while offering all the I/Os required to get your hardware into the loop as shown in Figure 2.

Figure 2 OP5600 real time simulator

2.1.1 RT SIMULATOR Hardware

{ Real-Time Computer with Intergarted I/Os }

OP5600 V2, RCP/HIL Spartan3 FPGA-based Real-Time Simulator - 4 cores (4U, 1 x Xeon E5 with 4 Cores at 3.0 GHz, 1 x 10M cache, 1 x 16GB RAM, 512GB SSD)

- Digital Output Card (32 channels, Push-Pull, galvanic isolation 5V to 30V)
- 16 PWM Frequency or Time Stamp Digital Output
- 16 Static Output Channels
- Digital Input Card (32 Channels Opto-coupler, 4.5V to 30V)
- 16 PWM Frequency or Time Stamp Digital Input
- 16 Static Input Channels
- Analog Input Card (16 Channels, 16 bits, 0.5 us, ±16V)
- Analog Output Card (16 Channels, 16 bits, 1 us, ±16V)

2.1.2 RT SIMULATOR Software

- RT-LAB 11.x Real-Time Target License - eMEGAsim FX Series (one target license required per activated core)
- RT-LAB Host/Workstation License – Professional Host multiple rate and multi processors/cores, node-locked
- Red Hat linux Intel C compiler
- Red Hat linux with Opal-RT optimized real-time kernel

The overview of OP5600 RTS is shown in Figure 3. The application of RTS is illustrated in Figure 4

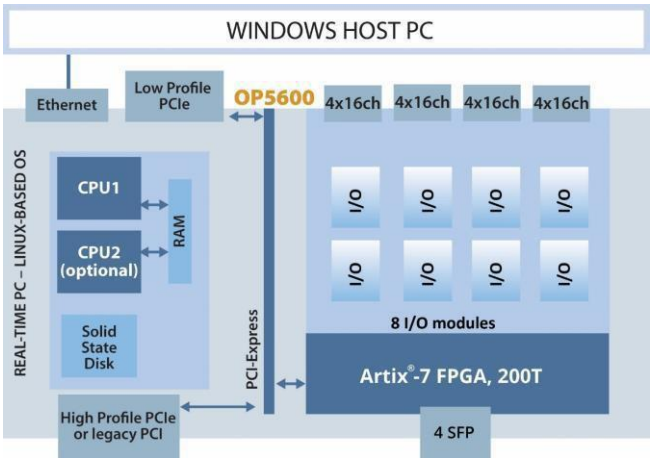


Figure 3 RTS over view

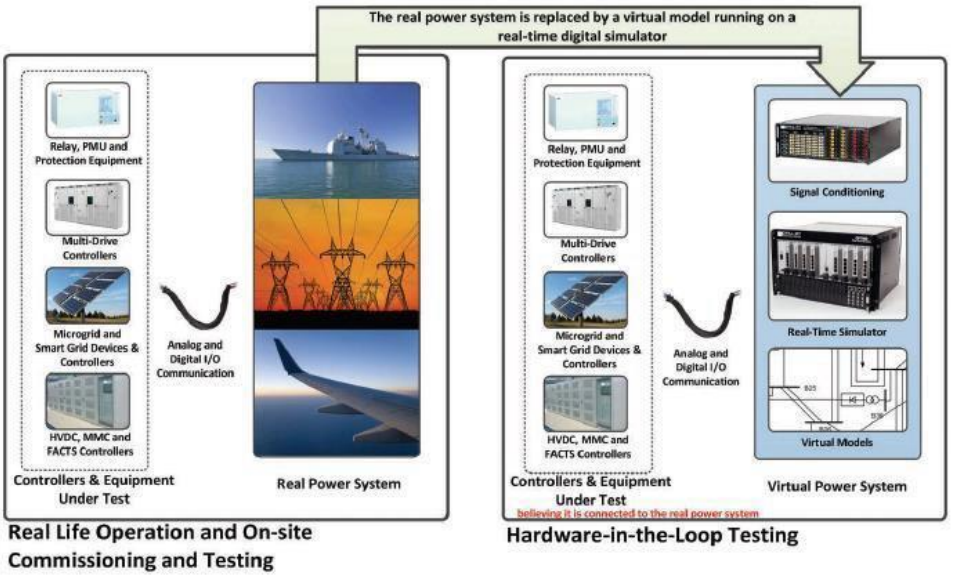


Figure 4 RTS applications

The RTS is used to simulate wind energy controller and configuration through the implementation of the hardware in the Loop as shown in Figure 5. The setup location and overview is shown in Figure 6.

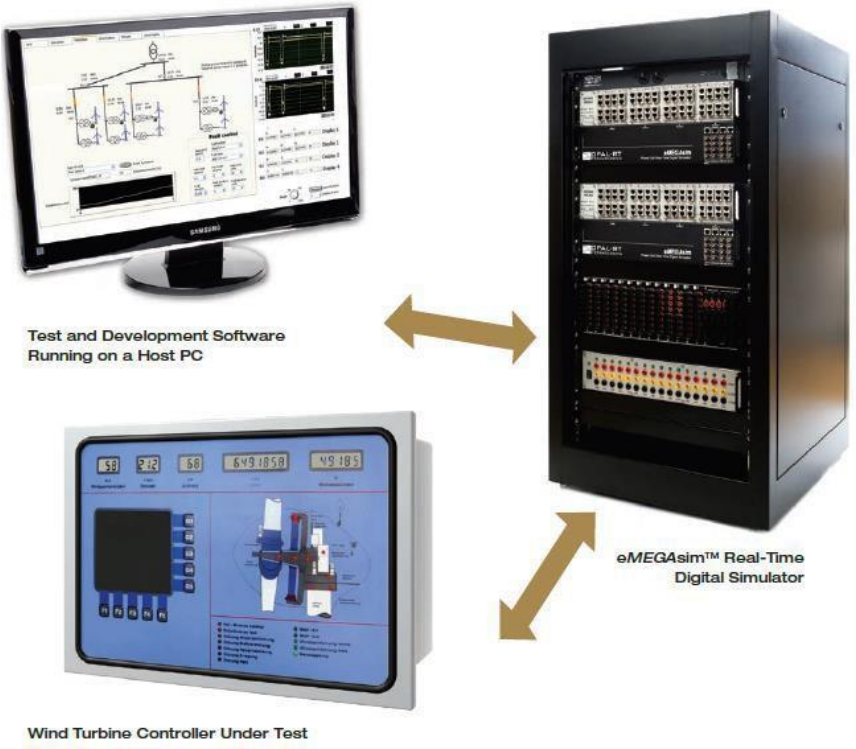


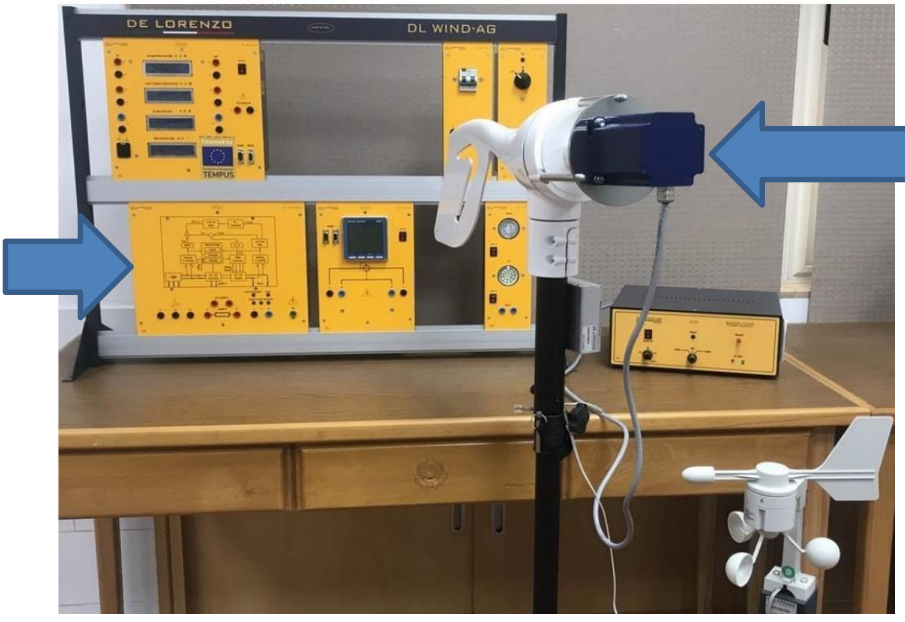
Figure 5 Hardware in the LOOP of RTS

Figure 6 Lab1 RTS overview

2.2 Wind energy setup

Additional hardware is bought to integrate the existing wind energy setup with Opal RTS to test the controller and operation of wind turbine. The wind turbine is grid connected configuration illustrated in Figure 7

Supported by JAMILA TEMPS project



Supported by WESET Erasmus plus project

Figure 7 wind Energy setup

- Didactic system for the study of the generation of electric energy from a wind turbine and its inlet in the mains network.
- The device includes a stepper motor kit to drive the wind generator in absence of wind.
- Complete with connecting cables, experiment manual and software for data acquisition and processing.

The overview of the system configuration and operation is shown in Figure 8

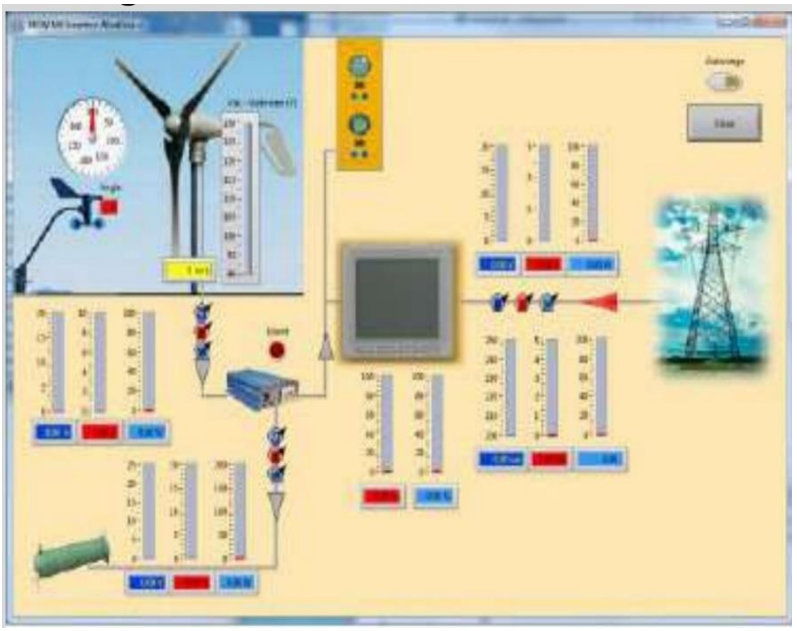


Figure 8 Wind energy setup configuration and operation

TECHNICAL SPECIFICATIONS

- A wind turbine, 400W, 12Vac.
- Anemometer and wind direction sensor mounted on a stand.
- A supporting frame for the modules.
- A braking resistance, 250 W, 3 Ohm.
- A load module. It includes two mains voltage
- lamps, dichroic 35W and LED 3W, with independent switches.
- A module for the measurement of: wind speed (m/s), wind direction (degrees), current up to 30V, ± 15A (two dc ammeters), voltage up to 30V and power up to 1000W.
- Grid tie inverter.

- An energy measurement module.
- A differential magneto-thermal switch.
- A network distributor.
- A motor kit for driving the wind turbine, composed of a stepper motor and a 300 W power supply.

The overview of wind set up and updated instrument is shown in Figure 8. The list of instruments is shown in Table 1. The photo of the setup during expermint execution is shown in Figure 10.

Figure 9 Lab2 Wind Energy setup integrated with measuring instrument

Table 1 list of instrument for lab2

Items No.	Description	QT
1	**Clamp meter:** 	3
2	**Wire Wound Resistor:** 	5
3	**Load Tester:** 	2
4	**Fixed Anemometer:** 	1

Figure 10 Lab2 photo during experiment

2.2.1 Instrument for wind energy measurement and instrumentation

a- wind speed and direction measurement system

Whole set of WTF-B200 wind vane anemometer includes WTF-B200 display, WFS-1 wind speed

sensor, SC/FX wind direction sensor and cables as shown in Figure 11.

Application

- Cranes, Weather, - Agriculture, Hydraulic and Hydroelectricity, Construction and Education

Figure 11 Wind measurement system

2.2.2 Multichannel oscilloscope, resistive loads, props and clamp meters

Different measuring and testing equipment's shown in Figure 12 are equipped in WEC including

1- Battery tester
2- Resistive loads
3- Oscilloscope
4- Current and voltage probs for Hardware in the loop application
5- Clamp meters
6- Accessories

Figure 12 Measuring and testing devices

2.3 Computer lab for simulation application (Lab3)

10 Pc's has been installed in college of engineering and technology. The overview of the lab is shown in Figure 13

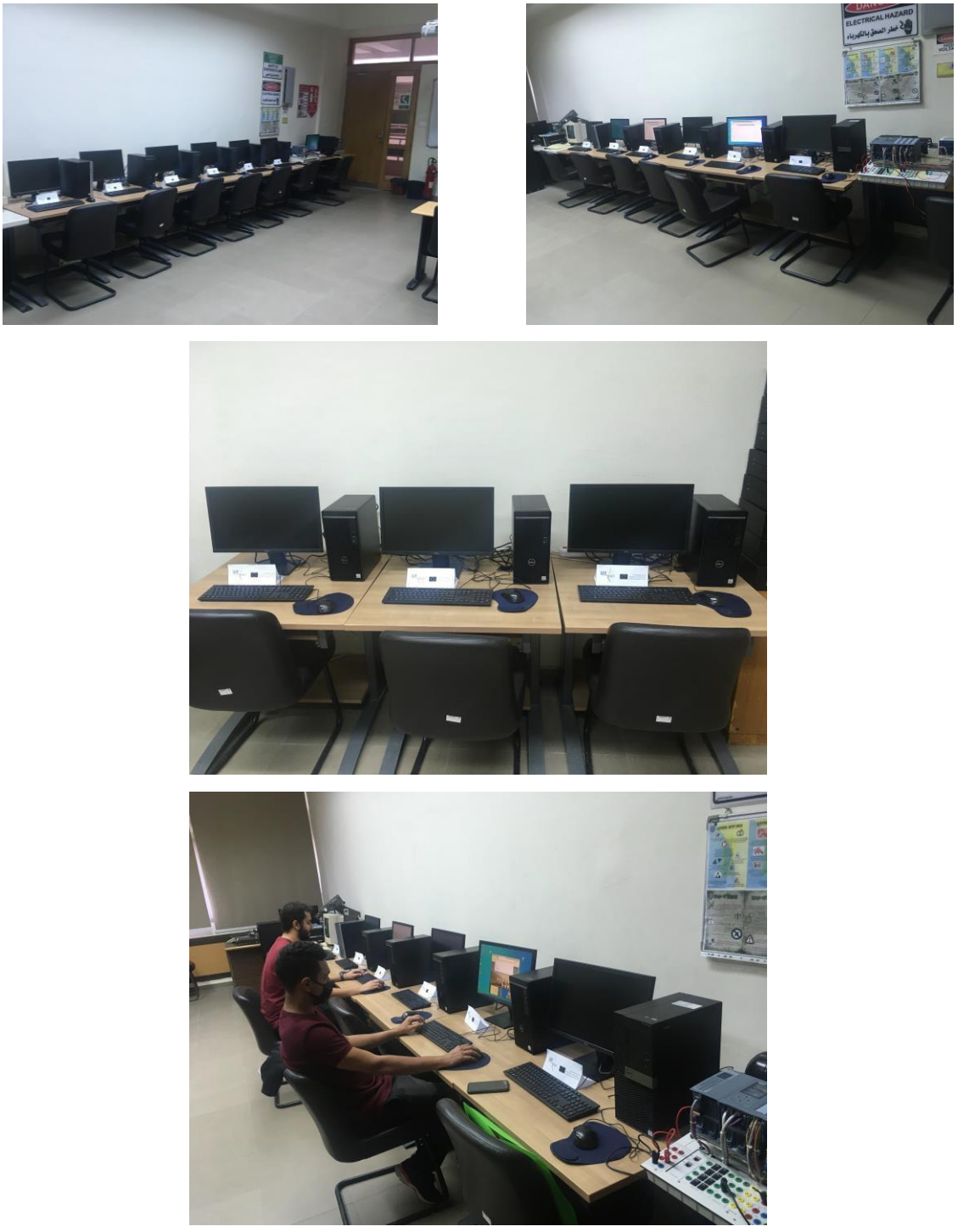


Figure 13 PC lab for simulation and control

2.4 Automation of wind energy (Lab4)

Additional setup of PLC, HMI and motor generator set to emulate wind turbine is installed in computer lab as shown below in Figure 14

Figure 14 Automation of wind turbine emulator

3. Courses using WEC lab

The WEC lab serves many courses undergraduate and postgraduate in addition to researchers.

3.1 Undergraduate courses

EE 523: Renewable energy course (BSc Electric and control Engineering)

ME 524: Renewable energy resources (Bsc Mechaical Engineering)

3.2 Postgraduate courses

EE 726: Renewable energy systems (MSc Electrical and Control Eng.)

EE 721: Wind Energy Conversion system (MSc Electrical and Control Eng.)

EE 7111: Advanced Control system for Renwable energy (MSc Electrical and Control Eng)

ME 723: Renewable Energy (MSc Mechanical Eng.)

CR 715: Wind power Technology and Development (MEng Renewable and environmental Eng.)

EG 7005: Renewable energy and Energy Conversion (MSc Renewable and environmental Eng)

EG 7210: Wind Energy (MSc Renewable and environmental Eng.)

CR 715 :Wind power Technology and Development (Meng Renewable and environmental Eng.)

The program and courses link: http://www.aast.edu/en/colleges/coe/alex/

4. Establishment of Wind Energy Center in the AASTMT

الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري
Arab Academy for Science, Technology & Maritime Transport

Date 13 November 2018

DECREE TO ESTABLISH WIND ENERGY LAB

This is a decree to establish WIND ENERGY Lab, taking into consideration the needs of the surrounding local community within the wind energy area. This Lab is a deliverable of an Erasmus Plus project entitled " Wind Engineering Skills in Egypt and Tunisia /WESET" in wind energy. This should assist in building a model for the environment change in MENA countries and use that to draw a road map for the wind energy and urban planning.

There will be also an emphasis on establishing formal links between governmental institutions and NGOs built within the WIND ENERGY LAB. Links and projects will help achieve the following:

[1] Promotion of collaborative research in areas of mutual interest.

[2] Collaboration in the offering of advanced hands-on training to students enrolled in both the undergraduate and postgraduate renewable energy programs at AASTMT.

[3] Development of projects that investigate topics related to **wind energy** applications.

[4] Developing and sharing knowledge of best practices in **wind energy** in the industry.

[5] Participation in jointly organized academic meetings, seminars, workshops and conferences.

[6] Developing courses in the postgraduate and undergraduate programs in AASTMT that are more relatable to the current wind energy conditions in Egypt.

[7] Developing wind energy areas in Egypt through the program and using the wind energy lab facilities to achieve community advancement.

Professor Alaa Abdel Bary,

Vice President for Postgraduate Studies and Research

Alexandria - Abu Qir Campus
P.O. Box 1029 - Miami - Miami Tel.: (+203) 5565429/5461163 - Fax: (+203) 5506042 - Aboki Tel.: (+203) 5622366/5622388 - Fax: (+203) 5610950

سوريا - فرع اللاذقية
Syria - Latakia branch
P.O Box 869 Latakia
Tel.: (+963 41) 458599
Fax: (+963 41) 453977

فرع جنوب الوادي
Ganoub Al Wadi branch
Aswan-Sachat Road- P.O.Box 11 Aswan
Tel.: (+2097) 2332843/ 2332845
Fax: (+2097) 2332842

القاهرة - فرع الدقي
Cairo - Dokky branch
23 Doctor Sobky st.
Tel.: (+202) 3748 1593/33365491
Fax: (+202) 33365492

القاهرة - فرع القرية الذكية
Cairo - Smart Village branch
B2401 - Smart Village
Tel.: (+202) 35370882/ 35370853
Fax: (+202) 35370881

القاهرة - فرع مصر الجديدة
Cairo - Misr El Gedida branch
P.O. Box 2033 - Elhorria
El Mashir Ismail st.-behind Sheraton Bldg
Tel.: (+202) 22685615/ 22685616
Fax: (+202) 22655892

www.aast.edu